Vol. 10 No. 2

The PROGRESSIVE FISH-CULTURIST

Vol. 10 No. 3

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JULY 1948

UNITED STATES DEPARTMENT OF THE INTERIOR
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PROGRESSIVE FISH-CULTURIST

Issued by

UNITED STATES DEPARTMENT OF THE INTERIOR - - - - - - JULIUS A. KRUG, SECRETARY
FISH AND WILDLIFE SERVICE - - - - - - - - - - - - - - ALBERT M. DAY, DIRECTOR

Printed with the approval of the Bureau of the Budget

Vol. 10, No. 3 July 1948

EDITORIAL STAFF

Editors

Mr. A. V. Tunison, Assistant Chief, Branch of Game-fish and Hatcheries, Fish and Wildlife Service.

Mr. Elmer Higgins, Chief, Branch of Fishery Biology, Fish and Wildlife Service.

Assistant Editor

Miss S. M. Mullin, Branch of Game-fish and Hatcheries, Fish and Wildlife Service.

Associate Editors

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Dr. A. S. Hazzard, Director, Institute of Fisheries Research, University Museums Annex, Ann Arbor, Michigan.

Dr. P. R. Needham, Director of Fisheries, Oregon State Game Commission, Portland, Oregon.

Mr. H. S. Swingle, Fish Culturist, Alabama Agricultural Experiment Station, Auburn, Alabama.

Dr. L. E. Wolf, New York State Fisheries Laboratory, Rome, New York.

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(See inside back cover)

The PROGRESSIVE FISH-CULTURIST

News and Views from many Sources on Practical Hatchery Problems

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RESULTS OF AN ANALYSIS OF FARM PONDS IN THE MIDWEST

EVALUATING POND PRODUCTION

Wallace L. Anderson
U. S. Soil Conservation Service
Milwaukee, Wisconsin

APPROXIMATELY 5,000 farm ponds have been stocked with fish by farmers cooperating with Midwest soil-conservation districts in the past 7 years. Of these, 3,600 were stocked with fish supplied by the U. S. Fish and Wildlife Service. State conservation departments furnished the fish to stock the remainder. No doubt many additional ponds have been stocked by farmers from local lakes and streams.

These ponds were planned and constructed as part of a soil and water conservation plan. The primary use of most of the ponds was to provide water for livestock in parts of the farm that are suitable only for use as permanent pasture; thus these ponds make a definite contribution to better land use. In addition, with proper stocking and management, they are capable of producing 100 to 200 pounds of fish per acre annually; thus they provide the farm family with a source of food equal to the beef production from an acre of pasture. Therefore, attaining maximum fish production becomes another important objective from the standpoint of good land use.

The Soil Conservation Service has given farmers the most up-to-date stocking recommendations, with respect to the species and numbers of fish to stock. As those recommendations were based on the research of Swingle and Smith in Alabama, we wanted to see if the recommendations were working out satisfactorily in the Midwest. Also, we wanted a reliable method of analyzing fish populations in farm ponds to see whether the desired results were being obtained. Such a method had to be reasonably accurate but simple enough to be taught to people not trained in fishery biology. It had to be rapid enough to permit the analysis of a large number of ponds in a few days. The Service was not interested in conducting detailed research on fish populations in farm ponds. What the Service needed was a quick method that could be applied to every pond that was stocked. That method should tell whether or not the pond is producing as much fish as may be expected. If something is wrong, the method should reveal what is wrong and how the situation can be corrected.

Because Mr. H. S. Swingle, fish-culturist at the Alabama Agricultural Experiment Station, had developed such

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See also:

Fuqua, C. L.
1947. An unusual type of farm pond. Prog. Fish-Cult. 9 (3): 125-129.

Holloway, A. D.
1947. Farm ponds. Prog. Fish-Cult. 9 (3): 155-158.

Thompson, W. H.
1947. Farm ponds--real and potential values. Prog. Fish-Cult. 9 (3): 133-135.

a method, the Soil Conservation Service sought his assistance. We made a 2-week trip through Ohio, Indiana, Illinois, Missouri, and Iowa to make analyses and to teach the method to Service personnel. During the 2 weeks (July 7-18, 1947), 116 bodies of water were analyzed. Most of these were farm ponds, but a few were city reservoirs or sportsmen's club lakes.

In each State, representatives of colleges and State conservation departments were invited to participate, and we were glad that most of them accepted the invitation and were present for at least part of the time we were working in their State. We wanted these men to participate because we felt that only through the cooperative effort of all the people interested in farm ponds could real progress be made in learning more about their management. We wanted to get the ideas of everyone who had something to contribute to this problem.

The method developed by Swingle and used on this trip is based on two principles: first, that the population of fish in a farm pond must be controlled if satisfactory fishing is to result; and second, that the degree of population control attained in any pond can be measured by studying the fish reproduction in that pond. The purpose of the largemouth bass-bluegill sunfish stocking combination in farm ponds is to set up a predator-prey relationship that will result in a relatively small population of fish. This is necessary if a high percentage of the fish are to attain food-fish size. When that condition exists, the pond is said to be "in balance" and it does produce good fishing in terms of a large number of moderate-sized fish. It usually does not produce "big ones" but rather produces the maximum poundage of fish of usable size.

When fish are overcrowded, the pond does not produce good fishing: it produces only small fish--too small to be used for food. When that condition prevails, the pond is said to be "out of balance." The fish are in poor condition, thin and emaciated. They do not spawn regularly, and when they do spawn they are so hungry that the spawn or the newly hatched fish are eaten very quickly. Therefore, in such a pond we do not find many fish that are young of the year.

Because this method depends on a study of the young fish, it can be used only between July 1 and September 15 of the second or any succeeding year after stocking. This is so because bluegills do not spawn until the water temperature has reached 80° F. (usually about July 1 in this region), and because bass ordinarily do not reach sufficient size to spawn during the first year after stocking. After September 15, we cannot rely on bluegill spawning and bass of the year are too large to be caught in a minnow seine.

Two men, equipped with bathing trunks and a minnow seine, can analyze a farm pond in a few minutes. The seine is passed through a small area of shallow water at the edge of the pond. An examination of the small fish in the seine will tell the story.

The pond is in balance if the seine contains both bluegills and bass of the current year's hatch, plus a few bluegills 2 to 3 inches in length. (See figure 1.)

The pond is overcrowded with bluegills if the seine contains many bluegills 2 to 3 inches in length, no young bass, and no bluegills (or only a few) of the current year's hatch. There may be a few large bass in such a pond; they will be well fed and will have spawned, but no young bass will be found because the hungry overcrowded bluegills will have eaten the bass eggs. There will be no young bluegills (or only a few) because all or most of the older bluegills are too undernourished to produce eggs. The presence of large numbers of crayfish or tadpoles also indicates that there are not enough bass in the pond. (See figure 2.)

The pond is overcrowded with bass if the seine contains bluegills of the current year's hatch, but none that are 2 to 3 inches long, and no bass of the current year's hatch. There will be a few large adult bluegills in such a pond; they will be well fed and will spawn continuously throughout the summer. There are, however, so many bass that practically all the young bluegills for the past few years have been eaten nearly as fast as they hatched; hence there are no bluegills of intermediate size. The bass may be so crowded that they have not had sufficient food to reach the weight

of 6 ounces (which is necessary before they can spawn) or they may be too undernourished to spawn. If a few did produce young, they were eaten by the other bass immediately after hatching. There will be no tadpoles or crayfish in such a pond. (See figure 3.)

The pond is overcrowded with other species of fish if the seine reveals the same conditions as described for a pond overcrowded with bluegills, except that green sunfish, bullheads, crappies, or other species will predominate.

Results of the analysis, made by the method described, are quite encouraging. A total of 81 ponds were known to have been stocked with bass and bluegills at the rate of 50 bass and 500 bluegills per acre for unfertilized ponds and at twice that stocking rate for fertilized ponds. Another 18 ponds were known to have been stocked with a miscellaneous group of fishes at various stocking rates. The results of the analyses are given in table 1. Data for 17 ponds, the original stocking of which was not known, are omitted.

The study indicated four principal reasons for the failure of ponds supposedly stocked in accordance with current recommendations to produce good fishing. They are:

1. Size of pond. In ponds that are extremely small, e.g., 1/10 acre, it is extremely difficult to maintain the proper number of bass to control the bluegill population. It is also difficult to produce enough fishing in small ponds to be worth the effort. The study indicated that 1/4 acre would be a reasonable minimum size for ponds that are to be used for fish production.

2. Size of watershed. When the watershed draining into the farm pond is too large, excessive siltation takes place and such a high percentage of the fish are carried over the spillway at times of high water that it is difficult to produce good fishing. Examples inspected on the trip included gully-control ponds having 1 acre of surface area into which drained 60 to 80 acres of watershed. Ten acres of watershed is probably adequate to supply water for any farm pond up to 2 acres in surface area.

3. Excessive weed growth. This factor makes it difficult for bass to catch and eat enough young bluegills to control the fish population in the pond. This condition can be controlled by good design, a minimum area of shallow water, and by fertilization.

4. Lack of care in stocking. Even when the right number and the right species of fish for stocking are ordered from the hatchery, a number of things can happen to prevent successful fish production. In rare instances, the hatchery may supply sunfishes other than bluegills. In one or two cases it seemed obvious that an error at the hatchery had resulted in the delivery of green sunfish in place of bluegills. The care of the fish from the time they leave the hatchery until they are placed in the pond, may not be the best. Some ponds were known to have been stocked with fish that had been in the hatchery truck so long that they were in poor condition when delivered to the farmer. The greatest chance for lack of care occurs after the farmer has received the fish. He may place them in a container that is too small, or he may leave them in the container too long while he shops for the groceries.

In addition to the factors already discussed, the data indicate that there may be a progressive tendency for ponds, as they age, to become overcrowded with bluegills or other fish. (See table 2.) This tendency probably indicates the need for rather heavy fishing pressure to prevent overcrowding.

All these possibilities point to the need for a reasonably accurate method of analyzing ponds at the earliest opportunity to determine whether a productive fish population has been established. It appeared from the study made last July that nearly all the instances of unsuccessful stocking with bass and bluegills could be attributed to one or more of the conditions just discussed. It also appeared that good fishing may be expected from the present stocking recommendations when fish are placed in ponds of proper design after receiving good care all the way from the hatchery to the pond.

This report has been presented to inform fishery biologists of what has been done and the method that was used. This report has been presented in the hope that fishery biologists with research

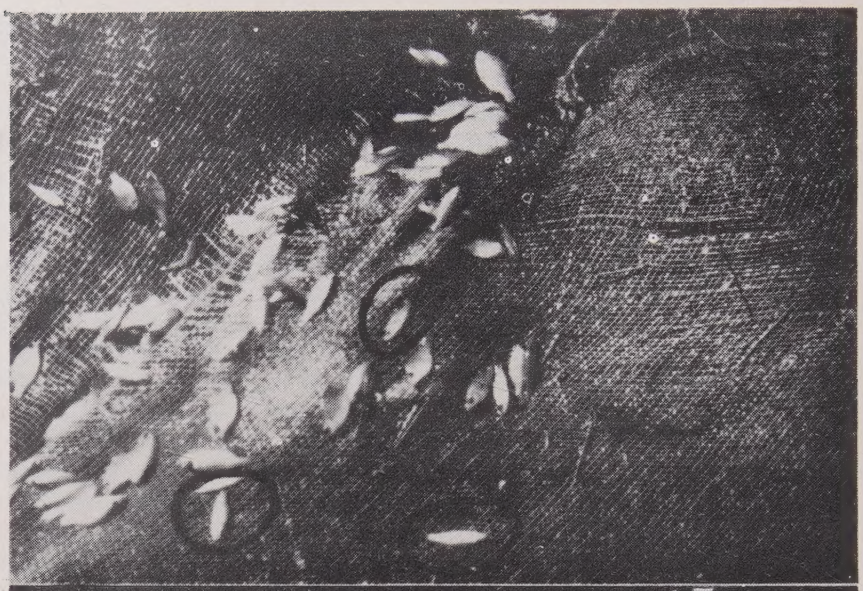


FIGURE 1.--Seine containing fish from a pond that is in balance. Note young bass (a few are circled). Bluegills had not yet hatched, but presence of young bass indicates that the pond is in balance.

FIGURE 2.--Seine containing fish from pond that is overcrowded with bluegills. Note absence of current year's hatch of either bass or bluegills.

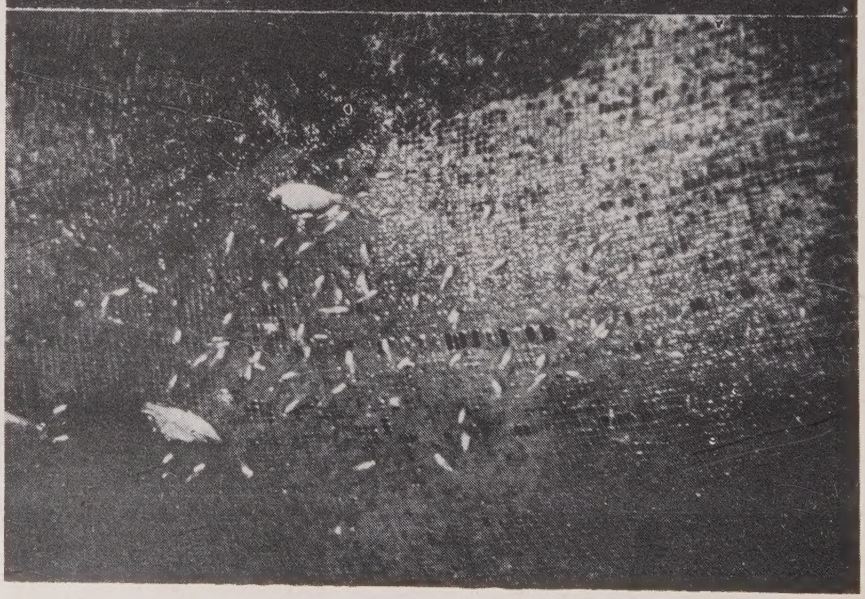


FIGURE 3.--Seine containing fish from pond that is overcrowded with bass. Note absence of bluegills of intermediate sizes and of young bass.

(Photos courtesy of author)

TABLE 1.--Results of analysis of 99 farm ponds in Illinois, Indiana, Iowa, Missouri, and Ohio in July 1947.

Present condition	Originally stocked with bass and bluegills						Originally stocked with other fish		Average, all ponds	
	Ratio, area of watershed to area of pond not greater than 10 to 1				Ratio, area of watershed to area of pond greater than 10 to 1					
	Pond area 0.2 acres or larger		Pond area smaller than 0.2 acres							
	No. Ponds	Percent	No. Ponds	Percent	No. Ponds	Percent	No. Ponds	Percent	No. Ponds	Percent
In balance	40	61.5	5	41.7	0	0	3	16.7	48	48.5
Overcrowded	25	38.5	7	58.3	4	100.0	15	83.3	51	51.5
with bluegills	5	7.7	4	33.3	1	25.0			10	10.1
with bass	5	7.7							5	5.1
with other fish	15	23.1	3	25.0	3	75.0	15	83.3	36	36.3
Total examined	65	100	12	100	4	100	18	100	99	100

TABLE 2.--The effect of age of pond on fish populations in ponds of good design with surface areas of 0.2 acres or larger, originally stocked with bass and bluegills.

Present condition	Year Stocked															
	Before 1940		1940		1941		1942		1943		1944		1945		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
In balance	1	25	1	100			1	50	5	45	11	61	21	72	40	61.5
Overcrowded	3	75					1	50	6	55	7	39	8	28	25	38.5
with bluegills	1	25							2	18	1	10	1	35	5	7.7
with bass									1	9	2	6	2	7	5	7.7
with other species	2	50					1	50	3	28	4	23	5	17.5	15	23.1
Total	4	100	1	100			2	100	11	100	18	100	29	100	65	100

facilities will have the opportunity to make similar analyses on a much larger scale, that they will compare this method of analysis with other methods to test its reliability, and that they will continue to expand the fundamental research on the management of fish populations in farm ponds. Fish production in farm ponds is an important use of land and water resources. As the population of the United States increases and natural resources become further depleted, making better use of water resources may become an even more important part of a conservation program. Ponds may become a very significant source of food for the people of the nation. Present-day research can lay the foundation for better pond management tomorrow.

PAINT MIXER

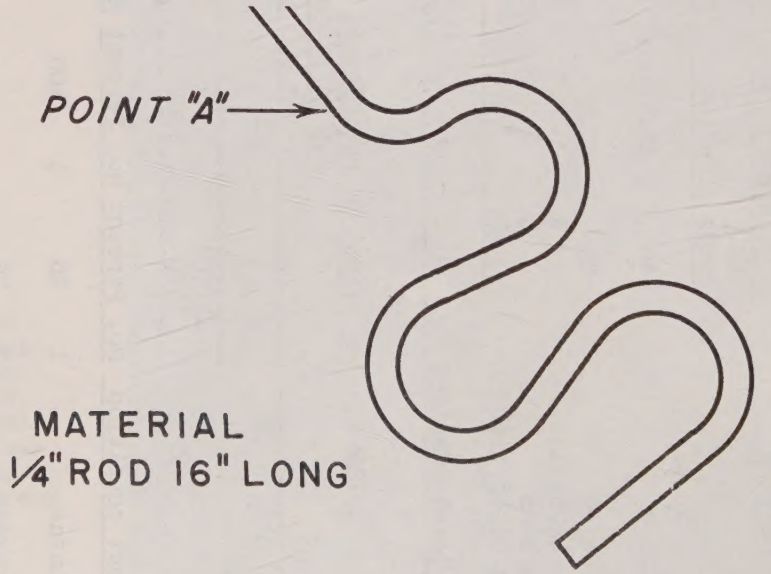
All fish-cultural stations have some painting to do, and a few stations have more than others. Mr. Paul J. Illk, fish-culturist at the U. S. Fish-Cultural Station at San Marcos, Texas, reports that use of this agitator with an electric drill or drill press greatly reduces time and labor in mixing a can of paint.

Used with a portable electric drill of 1/2-inch chuck capacity and 415 r.p.m., the agitator pictured has been very satisfactory for mixing 1-gallon cans of paint. This is also quicker and easier than the paddle method for 5-gallon containers, but a larger agitator is recommended if the station equipment can handle it.

The agitator must be reasonably well balanced, so that the drill will be easier to hold and the bucket will remain motionless.

The drill may be started when the agitator has been immersed to point A. It is advisable to raise and lower the agitator slowly, and--in 5-gallon cans--to move it about from side to side.

If the solids in the paint have completely settled, it is wise to loosen them with a paddle.



VITAMINOLOGY

Arthur M. Phillips, Jr.
U. S. Fish and Wildlife Service

and

Donald R. Brockway
New York State Conservation Department
Cortland, New York

PROBABLY no group of dietary essentials has caused so much interest or proved so useful as the group we call vitamins. Many years ago certain "diseases" were corrected with the diet in such a manner that the early workers, although unaware of this, were actually practicing the science of vitamin usage. Years ago the Chinese knew that certain foods prevented night blindness, which today is known to be caused by vitamin-A deficiency. In the 18th century the British required their navy to feed limes to the sailors to prevent scurvy: today we know that the British were preventing scurvy by feeding a food high in vitamin C. Not till the early part of the present century, however, was it recognized that certain dietary substances were needed in extremely small amounts. The substances were called vitamins because they were regarded as closely related chemical materials essential for life. Since then it has been shown that, although all are necessary, they are unrelated chemically.

The last 20 years have witnessed remarkable advances in our knowledge of vitamins. It has been shown that many diseases formerly thought to be bacterial in nature are due to nothing more than a lack of vitamins. The knowledge that has accumulated has led to the prevention of much misery among many of the poorer peoples of the world by permitting the use of low-quality foods when vitamins are added to the diet.

WHAT ARE VITAMINS?

Vitamins are substances that are needed by the body for life and growth. All forms of life require vitamins: even bacteria need vitamin B. Vitamins are needed in very small amounts. With many vitamins the amount needed is so small that no scales that we have today could be used to weigh the quantity; yet without vitamins life could not exist.

Vitamins are broadly classified as:

1. The fat-soluble vitamins. These are dissolved by the ordinary fat solvents, such as ether and alcohol. They are usually found in nature associated with natural oils, such as those of cod livers, wheat germ, and corn.

2. The water-soluble vitamins. These are soluble in water. Such products as beef liver and cereals are very high in the water-soluble vitamins.

In general, vitamins are widely distributed in food products, but, as might

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See also:

McCay, C. M., and Phillips, A. M., Jr. 1940. Feeds for the fish hatcheries. Prog. Fish-Cult. 52: 18-21.

Phillips, A. M., Jr. 1940. Meatless diets and anemia. Prog. Fish-Cult. 48: 11-13.

1947. This question of anemia. Prog. Fish-Cult. 9 (3): 151-154.

be expected, some foods contain greater amounts than others. Cod-liver oil is an excellent source of vitamins A and D. Wheat and yeast are considered rich in some of the water-soluble vitamins. Foods that are high in vitamin content are called vitamin concentrates; these foods, as well as commercial vitamin pills, are prescribed by physicians for patients suffering from vitamin deficiencies.

VITAMINS IN THE DIET OF WARM-BLOODED ANIMALS

As our knowledge of vitamin requirements deals largely with the warm-blooded animals, such as man, cattle, rats, chickens, and so forth, much of our application of the science of vitamins must be based upon results obtained with these animals. Fish are difficult animals to work with, and progress has been slow. Present-day practices are based largely upon the expedient assumption that, until it is proved otherwise, fish need the same factors as warm-blooded animals.

In this discussion we shall consider some of the more widely known and more essential of the vitamins.

The Fat-Soluble Vitamins

Vitamin A.--One of the earliest described vitamins, vitamin A is a preventive of the so-called night blindness of animals. An animal with night blindness cannot see properly in dim light: for example, a horse so suffering may run into a fence or wall in the twilight of the evening. Many supposedly blind animals that have been killed were actually afflicted with a vitamin-A deficiency, and these animals could have served many additional useful years if they had been fed a vitamin-A concentrate.

Vitamin A occurs in many foods, particularly in green and yellow plants, fish-liver oil, and many other products. The yellow color of carrots is due to carotene, a chemical compound which forms vitamin A or, as the chemist says, is the precursor of vitamin A.

Vitamin D.--Vitamin D has been called the sunshine vitamin, as the action of the sun's rays upon the skin forms vitamin D in the body. The discovery that vitamin D prevents rickets has saved many children who might otherwise have been deformed or crippled. Rickets was (and still is in many sections of the country) prevalent among the poorer people, especially in the larger cities. Because of poor diets and a lack of sunshine in the larger cities, rickets was a common sight a few years ago.

Vitamin D is found in any of the foods that ripen or grow exposed to the sun, as well as in many of the commercially available fish oils.

Vitamin E.--Vitamin E has been recognized as the essential factor in many cases of sterility among certain farm animals. Lack of the vitamin results in permanent sterility of the male and temporary sterility in the female. Recently vitamin E has been associated with the proper functioning of the nervous system, as well as with certain types of muscle tonus. In vitamin-E deficiency, permanent damage may be done to various muscles of the body, resulting in inability to use these muscles or in death.

Yeast, wheat germ, and various fish products are excellent sources of vitamin E.

Vitamin K.--Vitamin K was discovered by accident a few years ago while scientists were working with dogs and chickens. These experiments showed that vitamin K was necessary for blood-clotting. Without vitamin K, it is possible for an animal to bleed to death. Vitamin K has been useful in the nutrition of expectant mothers, and many fatal hemorrhages during childbirth have been prevented thus.

Vitamin K is not so widely distributed in our foods, but it follows the same general distribution pattern as other fat-soluble vitamins.

The Water-Soluble Vitamins

Vitamin C.--Vitamin C is the preventive of scurvy, a disease which in the early days was one of the worst scourges of mankind. Sailors on long voyages developed this condition, which resulted in much misery and many deaths. People of

GRAPHIC COMPARISON OF A ONE GRAM STANDARD WITH THE MILLIGRAMS OF B VITAMINS REQUIRED PER DAY BY ONE KILOGRAM (1000 GRAMS) OF TROUT

northern countries suffered from scurvy during the winter months, and it was prevalent among the poorer peoples of the world. Today we know that vitamin C prevents this trouble, and that a disease which was once considered a bacterial infection can be cured by dietary means. Today there is little excuse for this country to have even a single case of scurvy, although it is still found in some of the poorer districts where people cannot afford fresh fruits and vegetables.

Vitamin C is found in fresh fruits and many vegetables. Green or leafy vegetables, citrus fruits, tomatoes, apples, and many other fruits are rich in this substance.

Vitamin-B Complex.--Years ago this complex was described as vitamin B. Since that time, what was regarded as one vitamin has been shown to consist of many separate dietary essentials. These members have been grouped into what is known as the vitamin-B complex. Today the individual members of this complex run to great numbers. Many of these are somewhat obscure, and others have proved to be of minor importance.

The distribution of these vitamins follows a somewhat general pattern. Grains, livers, yeast, and egg yolks are good sources of most of these vitamins.

The discussion that follows will deal only with the more important members and those that are or may be of importance in the rearing of fish.

Vitamin B_1 or Thiamine.--Of all the known vitamins, this vitamin has proved to be one of the most diversified in body uses. It was originally described as the preventer of beriberi in man and animals, but since that time we have learned that vitamin B_1 is connected with many body functions. Vitamin-B_1 deficiency results in extreme nervousness of the animal; apparently the substance is needed for normal nerve function. In addition, vitamin B_1 promotes growth, allows normal use of carbohydrates and fats in the body, and is essential to reproduction. Recently vitamin B_1 has been useful in treatment of certain types of paralysis and rheumatism. Thiamin or B_1 chemistry has advanced to the point where the substance is readily available in commercially made synthetic products.

Vitamin B_2 or Riboflavin.--This was the second factor isolated from the B complex. It is a dietary essential for the nervous system; in extreme deficiencies of riboflavin, a breakdown of the central nervous system may occur. Riboflavin is also associated with proper growth, life span, physical weakness and cataract of the eyes. What the physician calls cheilosis, or sores at the mouth corners, is a symptom of riboflavin deficiency.

Vitamin P-P or Niacin.--This vitamin is also called nicotinic acid, but because the name suggests an association with the nicotine of tobacco, it has been suggested that the term niacin be applied to this vitamin. Niacin has recently, relatively speaking, come into its own as an important food substance. A deficiency of this element results in black-tongue in dogs, pellagra, anemia, and many nervous disturbances.

Vitamin B_6 or Pyridoxine.--The role of pyridoxine has not been fully established, but it is evidently concerned with several processes in the body. It has been demonstrated that pyridoxine is essential in the prevention of certain types of anemia and is concerned with growth. A deficiency of B_6 results in an abnormal skin condition, and in extreme conditions lesions may develop in the outer tissues.

Pantothenic Acid.--This is another of the vitamins that have not been fully explored. Its use in human nutrition has not been completely established, but its value to other animals has been shown. In deficiencies of pantothenic acid there is a reduction in growth, loss of appetite, and anemia. Incrustations of the mouth and skin lesions may develop in advanced stages of pantothenic-acid deficiency. Lack of this vitamin has been associated with the graying of the fur of certain animals, although its effect upon gray hair in human beings has not been confirmed.

Folic Acid.--This is one of the newer B vitamins. Its status is receiving a tremendous amount of attention. It is concerned with normal growth and the blood picture in chickens. A deficiency of folic acid may result in a severe anemia in chickens.

Biotin.--This is also a relative newcomer to the vitamin family. In its short acquaintance with the nutritionist, however, biotin has shown itself to be very valuable. Biotin is concerned with the growth of the animal, and there have been suggestions that an overstimulation of cell growth by this vitamin results in certain pathological conditions. Many feel that when the full story of biotin is known, it will be regarded as one of the most important of the vitamins.

Choline.--Although choline was known many years ago, it was not classed at first as a vitamin. Choline has now been placed in this category and is considered a member of the B complex. Choline is essential for normal utilization of fat by the body; a deficiency results in the formation of so-called "fatty livers." Choline plays an important role in the body, and its absence results in pathological conditions that greatly impair normal function of the body tissues.

VITAMINS IN FISH NUTRITION

Studies upon the actual vitamin requirements of trout have been relatively few. Fish are difficult animals to work with because at present we do not recognize many deficiencies of vitamins in these animals. There has not been sufficient work with fish to establish the full picture of vitamin needs. Frequently it is necessary to open the fish's body to discover the results of a lack of vitamins, and little work has been done along these lines.

There have been three general lines of approach in vitamin studies upon fish. First, there is the trial-and-error method, in which vitamins are fed and an attempt is made to measure the rate of growth. These experiments, at best, are inaccurate and difficult to make. Second, in the few cases where we recognize vitamin deficiencies, attempts have been made to feed known amounts of vitamins and then to determine at what level the pathological condition is corrected. Because fish are fed in water, it is difficult to prevent leaching of the vitamins in the water, and the researcher is never certain how much of the vitamin actually enters the body of the fish. The third method employed has been rather indirect: in this type of study the researcher determines how much of the vitamin content in the food is needed to produce a maximum storage in the fish's liver. As most of the B-complex vitamins are stored only to a limited extent, it is possible to feed diets containing various amounts of the vitamins and to determine which food level caused maximum storage. These studies do give a base from which to work, although, at best, they have definite limitations. This last method has been applied for several years, and some values are available.

The discussion of vitamin requirements will be divided into three parts: first, those vitamins that are known to be needed by trout; second, those which we suspect are needed; and third, those for which we have values as to the amount needed to cause maximum liver storage but for which we have no knowledge of their requirement by fish.

Essential Vitamins

Pantothenic Acid.--Several workers have shown that pantothenic acid is essential for the prevention of a certain type of gill disease. Some of these workers believe that it is the preventer of the so-called "western" type of gill disease in trout, whereas others believe pantothenic acid corrects all gill disease. A deficiency of pantothenic acid does result in a proliferation of the gill tissues, a fusion of the fine branches of the gill, and finally the death of the animal. It has been reported that between 0.97 and 1.25 milligrams of this vitamin per kilogram of fish weight are needed daily to permit maximum storage of pantothenic acid in the liver of the trout. Such levels should be well above the danger point for the formation of "western" gill disease. No difference has been found in the requirement of brook, brown, or rainbow trout; and water temperature has not affected the requirement.

Among fish foods, two of the best sources of pantothenic acid are liver

products and dried skim milk. Spleens, fish meal, and wheat middlings are fair sources.

Thiamin or B_1.--As in the case of pantothenic acid, several widely separated workers have shown that trout have a definite need for this vitamin. A deficiency results in extreme nervousness of the fish, a retracted head, and a curious sheen to the body. When scared or in the greatest struggle for life, the fish lie on their sides, breathing heavily, and finally may die. Thiamin is a definite cure for this condition. It has been shown that a thiamin deficiency may result from feeding certain fish products in the diet. These products, for all practical purposes, destroy the thiamin present; hence a diet which may have been rich in thiamin becomes deficient because of the action of the fish products. Such conditions may be prevented by omitting the fish from the diet, by feeding the product on alternate days, or by cooking the fish. The tentative requirement of thiamin has been established at between 0.150 and 0.186 milligram per kilogram of body weight daily. Brook, brown, and rainbow trout were found to have the same requirement; and water temperature did not affect the need.

Wheat products, such as middlings, and livers are the best sources of thiamin. Any of the plant concentrates are at least fair in B_1 content.

Choline.--A deficiency of choline results in the formation of "fatty" livers in trout. Choline is needed by the fish, but the usual hatchery diet normally contains a sufficient quantity to prevent trouble. There are no values available as to the amount needed by fish.

Factor H.--An anemia in fish results from lack of factor H. This was originally thought to be a single unknown factor, but relatively recent studies have pointed to the conclusion that factor H is not a single factor but rather a mixture of several vitamins. Although much time and effort have been spent upon the study of factor H, the picture is far from complete and much additional work must be done.

Feeding fresh meat prevents the formation of anemia. If the diet is properly prepared, stored, and fed, anemia should be prevented easily.

Vitamins That May Be Needed by Trout

The vitamins discussed in this section are those for which some need has been shown but whose full role has not been established. More work must be done with this group before a definite need can be shown.

Vitamin B_6 or Pyridoxine.--It is suspected that this vitamin, believed to be connected with the factor-H group, is concerned with anemia in trout. It has been shown that anemic fish have a low storage of this vitamin in their livers, and in one study it was shown that pyridoxine helped to restore the normal blood count of anemic fish, but a repetition of this work did not bear out these conclusions. By means of maximum-storage studies, however, it has been shown that between 0.225 and 0.250 milligram of pyridoxine per kilogram of fish weight is needed daily to cause maximum storage in the livers of trout. Only brook trout were used in these studies.

Vitamin B_2 or Riboflavin.--No definite role has been assigned to riboflavin, but, as with pyridoxine, it has been shown that anemic trout have a low storage of this element in their livers. Possibly riboflavin has some relation to the anti-anemic factors. The important role of riboflavin in warm-blooded animals certainly warrants consideration of this vitamin in fish nutrition. Tentative requirements for trout have been established at between 0.44 and 0.68 milligram of the vitamin per kilogram of body weight daily. Brook, brown, and rainbow trout showed no difference in requirement; and water temperature had no effect.

Livers and dried skim milk are good sources of riboflavin, the spleens and other dry feeds running a poor second.

Folic Acid.--This vitamin has received but little attention, but there are some indications that it may have some bearing upon the anemia developed in brook trout. No values have been reported for the possible requirement of trout.

Xanopterin.--This is a new member of the vitamin-B complex that has been associated with anemia in fish. Its role

in connection with factor H has not been definitely established. There are no values available for the possible requirement for fish.

Vitamin A.--It has been reported that a lack of vitamin A results in the formation of a cataract in the eyes of trout. It has been shown that the amount of vitamin A stored in the liver is proportional to the amount in the diet of the fish. These studies have not been conclusive enough to permit statement of a definite need in trout for this vitamin, but the evidence certainly points to a positive conclusion, and vitamin A should be regarded as essential until proved otherwise. In addition to these reports, there are a number of experiments in which cod-liver oil has bettered the rate of growth of trout. As the content of vitamin A is high in cod-liver oil, this may be the important factor.

Vitamin D.--Only very indirect evidence supports the contention that fish need this vitamin. As cod-liver oil is a concentrate of this vitamin, the increased rates of growth from the addition of cod-liver oil, as reported in the literature, may be tied in with vitamin D. Much additional work must be done before the role of vitamin D in trout nutrition can be established.

Vitamins for Which No Definite Need Has Been Established

Although no definite need for these vitamins has been shown, a direct relationship has been found between the amount in the diet and the storage in the liver. It is therefore assumed that although no need is known at present, these vitamins may play a role in trout nutrition.

Vitamin P-P or Niacin (Nicotinic Acid).--Studies reported have shown that there is a direct relationship between liver storage of niacin and the amount present in the diet. There was no difference found in the amount of dietary niacin necessary to cause maximum storage in either brook, brown, or rainbow trout. Water temperature had no effect upon storage. It was necessary to feed between 3.0 and 4.1 milligrams of niacin per kilogram of fish weight daily to cause maximum storage, and this has been established as the tentative requirement of trout.

Biotin.--Biotin has been studied in a manner similar to that used with niacin. We do not recognize any definite deficiencies for this vitamin, but by the methods described the amount necessary to cause maximum storage in the liver of trout has been determined. Biotin is needed in very small amounts. This vitamin is very important in higher animals, and doubtless will eventually prove to be one of the more important in trout nutrition. One of the interesting facts brought out by these studies is that among species there is a definite difference in the amount of dietary biotin needed to cause maximum liver storage in the trout. Brook and rainbow trout required between 0.00678 and 0.0268 milligram per kilogram of body weight, and brown trout required between 0.0433 and 0.07698 milligram. This difference in requirement may prove to be one of the most valuable of recent nutrition studies with trout, as it offers a new approach to the study of species differences.

GENERAL DISCUSSION OF VITAMINS IN TROUT DIETS

Vitamins have formed the basis of nutrition among the higher types of animals, and until more is known about the vitamin requirements of trout, it is impossible to approach the so-called balanced diet. In connection with trout, the term "balanced diet" is certainly misused, as at present we cannot state what this implies. Many of the diseases now attributed to unknown causes may be shown to be vitamin deficiencies. It is essential that every precaution be taken to give trout the best food possible.

As we know so little about the vitamin requirements of trout, the only safe assumption--until it is proved otherwise--is that trout need vitamins. Trout diets should contain all the vitamins needed by the higher animals.

If the dietary vitamins are to be taken in by the fish's body, the food must be handled so as to insure their preservation. Freezing is the best method for

preserving vitamins, and such products as meats should be kept frozen until they are thawed for grinding. No more meat than will be used should be prepared for grinding. Once frozen, meat loses its vitamin content rapidly through loss of juice while thawing. Spoiled meat may have much of its vitamin content destroyed. Every precaution should be taken to care for the trout's food in a manner similar to that used in caring for the food of the fish-culturist.

Foods should be mixed only for short periods. They should not stand for long periods, even at relatively cool temperatures, before feeding. A good rule is to mix the food daily or, at most, at intervals of not more than 2 days. When foods are prepared and allowed to stand, there is an excellent opportunity for oxidation to occur, and such processes destroy some of the vitamins very rapidly. In addition, some foods react upon the vitamins, either destroying them or inhibiting their use by the body. The interaction of thiamin and fresh fish was described in an earlier paragraph of this paper. There may be many other such relationships about which we do not know now.

The binding of a diet by the use of salt and such products as spleens and some of the livers (pork, for example) results in a considerable saving of the food value of the diet by the prevention of loss in the water. This is one of the most valuable assets of a bound diet.

Many of our concentrates are relatively low in some of the vitamins (particularly riboflavin and pantothenic acid). It is therefore a good practice to add between 10 and 15 percent of beef liver to the diet of trout as an insurance factor, as beef liver is an excellent source of many vitamins. Such a practice may prevent a serious condition due to deficiency of vitamins, both known and unknown.

U. S. Fish-Cultural Station,
Cortland, New York.

CHEMICAL CONTROL AGENTS AND THEIR EFFECTS ON FISH

Eugene W. Surber
U. S. Fish and Wildlife Service
Kearneysville, West Virginia

FOR MANY of the new chemical compounds useful to man in his war against pests, both plant and animal, the thresholds of toxicity to fish are, for the most part, being determined only roughly at present. Knowledge of precise lethal limits must await perfection of methods of determining small quantities of the newer compounds, most of which are complex in chemical structure. In the meantime, studies of the effects on fish, on their food, and on various forms of wildlife are proceeding along operational lines. From an ecological standpoint, this seems an ideal method of approach, as all implications of the operations may be viewed in their entirety.

INSECTICIDES

A. DDT.

Experiments conducted in the laboratory and in small ponds where spraying operations have been performed by hand, have demonstrated that DDT is very toxic to fish.

In aquarium experiments at the University of Georgia, Odum and Sumerford (1946) showed that DDT dissolved in acetone would kill goldfish at 0.1 p.p.m., Gambusia at 0.01 p.p.m., and Culex larvae at 0.001 p.p.m. In experiments in aquaria at the Illinois State Laboratory (unpublished report),[1] golden shiners were unaffected by concentrations of less than 0.2 p.p.m. of DDT, but all fish died at concentrations of 0.5 p.p.m. or more.

Many aquarium experiments have been conducted at Leetown, West Virginia, with different rates and formulations of DDT. In one series of experiments, bluegill sunfish (Lepomis macrochirus) were killed by an application of 0.25 pound of DDT (0.14 p.p.m.) in a fuel-oil formula, whereas blacknose dace (Rhinichthys atratulus) and bluntnose minnows (Hyborhynchus notatus) were unaffected. Wettable DDT at the same rate did not kill these species. In another series of experiments, which included darters (Catonotus flabellaris), sculpins (Cottus cognatus), and blacknose dace, wettable DDT at the same rate destroyed the darters and sculpins but the dace again survived.

One-fourth pound of wettable DDT per acre (0.14 p.p.m.) killed rainbow, brook, and brown trout (Salmo gairdnerii, Salvelinus fontinalis, Salmo trutta, respectively) in aquaria containing 20 liters of water only, but no brook trout and

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See also:

Bauman, A. C.
1947. 2,4-D and some emergent aquatics. Prog. Fish-Cult. 9 (2): 71-77.

[1] Von Limbach, Bruno. The toxicity of DDT to fish and other aquatic animals. Nat. Hist. Survey Rept., Urbana, Ill., 1944.

very few brown and rainbow trout were killed in aquaria containing 18 liters of water and 2 liters of settled mud. The role of mud in inactivating the DDT was clear.

Prevost (1946) has observed that fish in aquaria may themselves absorb DDT, and their density in experimental containers has affected the minimum lethal dose.

We have been able to assay more accurately the thresholds of toxicity in concrete daphnia ponds (25 by 8 by 3 feet) containing approximately 450 cubic feet of water. In these ponds, 0.25 pound of DDT per acre in a fuel-oil formula killed bluegill sunfish at 0.04 p.p.m. but did not kill blacknose dace, creek chubs (Semotilus atromaculatus), bluntnose minnows, spotfin shiners (Notropis spilopterus), and common shiners (Notropis cornutus). A series of experiments performed during cool weather and without running water showed that rainbow trout, largemouth black bass (Micropterus salmoides), and golden shiners (Notemigonus crysoleucas) could survive a 1-pound per acre wettable DDT treatment (0.18 p.p.m.) which killed bluegill sunfish and black crappies (Pomoxis nigro-maculatus).

In conducting these pond experiments it was found that the condition of the fish made a considerable difference in their susceptibility to DDT. If they were well fed, they were able to withstand higher concentrations of DDT. Fry of largemouth and smallmouth bass (Micropterus dolomieu) and golden shiners were more susceptible to DDT than fingerlings or older fish. DDT at 0.25 pound per acre (0.025 to 0.04 p.p.m.) or more, killed them.

The most susceptible species included the smallmouth black bass, black crappie, bluegill sunfish, white sucker (Catostomus commersonnii), and hog sucker (Hypentelium nigricans). Species less susceptible included the largemouth black bass, creek chub, common shiner, spotfin shiner, brook and rainbow trout. The most resistant species were the blacknose dace, bluntnose minnow, golden shiner, and brown bullhead (Ameiurus nebulosus).

Surber has shown (1946a) that in dirt-bottom ponds supplied with hard water several warm-water species were able to withstand relatively high concentrations of DDT, up to 1 pound per acre in a fuel-oil formula. Field studies (Hoffmann and Surber, in press) corroborate the observation that larger fish are able to withstand higher concentrations of DDT than young fish.

The picture of the current use of DDT for mosquito control is far from discouraging. The conference of the American Mosquito Control Association in Asheville, North Carolina, October 16-19, 1947, disclosed that 0.1 pound of DDT per acre per application had proved more than adequate as a larvicide for anopheline mosquitoes in large control operations.

There is the encouraging prospect that the dosage for anopheline-mosquito control is likely to be reduced from 0.1 pound per acre per application to 0.05 or even 0.025 pound per acre as methods of aerial application are perfected. These concentrations will not reduce the plankton population to any practical extent, according to Bishop (1947).

Fifteen applications per season in Tennessee Valley Reservoirs during 1947 failed to produce mortality among fish. From observations of natural fish populations in Sweetwater and Whiteside Bays of Wheeler Reservoir after 16 applications of thermal aerosols by plane during a full season of experimental DDT treatments, Hess and Keener (1947) concluded that the fish populations were in no way injured.

The extensive work (unpublished) of Tarzwell and his associates of the Technical Development Division, Communicable Disease Center, Savannah, Georgia, with DDT at larvicidal rates, showed no appreciable kill of fish from routine airplane applications of 0.1 pound per acre as a thermal aerosol or spray; but oil sprays applied by hand (Tarzwell, 1947), even at 0.05 pound per acre, killed fish in shallow ponds.

Larger quantities of DDT, from 0.2 to 0.5 pound per acre, are being used as larvicides and adulticides for culicine mosquitoes; and where used over open waters, mortality of fish may be expected. Fortunately for both fish and fish-food organisms, applications over open water are not required except in localities where plant debris is on the surface.

In field tests over open ponds at Orlando, Florida, the Army Air Forces Committee on Aerial Dispersal of Insecticides found that applications of 0.3 and 0.6 pound of DDT per acre were injurious to fish, and that sometimes they died as much as 11 to 14 days after the spray had been applied to the pond surfaces.[2]

Higher dosages of DDT per unit area will be used in the control of certain forest-tree pests. Authorities in the field of forest-insect control now believe that for most defoliators it will seldom be necessary to use more than 1 pound of DDT per acre. Studies reported by Cottam and Higgins (1946: 6) have disclosed that dosages greater than 1 pound per acre are likely to kill considerable numbers of fish in streams. Hoffmann and Surber (in press), and Nelson and Surber (1947) have reported fish mortalities in all experiments performed to determine the possible damage to fish and other aquatic organisms by aerial applications of DDT at high rates. At 1 pound of DDT per acre, damage has been slight in proportion to total fish populations. Damage to fish-food organisms, on the other hand, has been considerable immediately after one spray application, according to Hoffmann (1946), but the effect is not permanent. The ultimate effects of repeated treatments of streams in forest areas will not be known until there has been further study; however, repeated applications to forests, except low dosages as for mosquito control, may rarely be necessary.

Emulsions of DDT are much more toxic to fish than oil sprays in open water, whereas wettable DDT and dusts have been found less toxic. Suspensions have not been widely used in large-scale aerial operations because of the difficulty in mixing and maintaining uniform flows from airplane spraying nozzles.

Though it is obvious that our freshwater fish are very sensitive to DDT, it also appears that many outdoor uses of DDT will be possible without causing critical effects. If open waters are avoided in aerial applications of DDT, and if orchard operators are careful in the cleansing of their spraying equipment, the dangers to fish may be minimized.

B. Other Insecticides.

A number of new insecticides may prove more effective than DDT for certain types of insect control. For example, entomologists have found benzene hexachloride more effective than DDT in the control of bark beetles, Mexican bean beetles, cotton boll weevil, and potato beetles; chlordan has proved more effective than DDT on grasshoppers; toxaphene has been more useful in cotton fields for control of cotton boll weevil.

Several of those which are coming into common use have been tested for their toxicity to fish. When benzene hexachloride and chlordan were applied to pond surfaces at the rate of 0.25 pound per acre (0.04 p.p.m.) in field formulations for airplane application,[3] they failed to kill fish. On the other hand, toxaphene (F) killed all fish at this rate. Toxicity of the latter compound is of the order of derris and cube powders (5 percent rotenone content), which killed our common warm-water fish at the low rate of 0.125 p.p.m., although the effective rate for eradication of fish populations is 0.25 p.p.m. (0.0125 p.p.m. rotenone). Even at 1 pound per acre (0.45 and 0.18 p.p.m. in different ponds), the gamma isomer of benzene hexachloride (F) failed to kill bluegill sunfish, goldfish (Carassius auratus), creek chubs, blacknose dace, common shiners, fallfish (Leucosomus corporalis), bluntnose minnows, sculpins, golden shiners, and darters. In aquarium tests, this isomer of benzene hexachloride (F) was not toxic to inch-long bluegills at 0.45 p.p.m. The pure gamma isomer dissolved in acetone did not kill 2.9-inch bluegills at concentrations of 0.0125 to 0.03 p.p.m. but

2/ Captain Earl S. Herald reported orally on these findings (unpublished) at the Meeting of the American Society of Ichthyologists and Herpetologists at Pittsburgh, Pennsylvania, April 16-18, 1946 (Copeia, 1946 (3): 181.)

3/ Twelve-percent solutions in napthenic solvent and fuel oil. Hereafter field formulations will be designated by the letter F, and pure or nearly pure chemicals by the letter P. The solid chemicals have been dissolved in acetone.

was highly toxic to inch-long trout. During experiments with these species, the gamma isomer at 0.02 and 0.05 p.p.m. killed both rainbow and brown trout. The threshold of toxicity for rainbow trout is in the neighborhood of 0.0125 p.p.m. This concentration and 0.025 p.p.m. killed rainbow trout but did not affect 1-inch brown trout. Experiments with the beta and delta isomers in the pure form, dissolved in acetone, demonstrated that they were less toxic. The beta isomer at 0.2 and 0.5 p.p.m. did not kill small rainbow and brown trout. The delta isomer at 0.5 p.p.m. severely affected both species, but they recovered.

On the other hand, chlordan (F) proved more toxic to fish at 1 pound per acre, killing 87 percent of the bluegill sunfish used in the experiments. Experiments with pure tetraethyl pyrophosphate on bluegill sunfish in aquaria show that this compound is toxic to these fish at concentrations of 0.30 p.p.m. From experiments conducted with toxaphene, it is now apparent that this new insecticide is more toxic than derris. At 0.02 p.p.m. toxaphene (F) did not kill goldfish, but it killed bluegill sunfish, creek chubs, blacknose dace, common shiners, fallfish, bluntnose minnows, sculpins, golden shiners, and darters. Pure toxaphene at 0.01 p.p.m., and even at the amazingly low concentration of 0.005 p.p.m. (1 part in 200,000,000), killed 1-inch rainbow and brown trout.

Parathion, in the purest form available, did not kill inch-long rainbow and brown trout at 0.063, 0.189, and 0.378 p.p.m. Experimental work on the effects of parathion on bluegill sunfish has not been completed, but some fish of this species were killed at 0.063 p.p.m.

The efficiency of rotenone as a fish poison is being increased through the use of emulsifying agents. Experiments conducted by Dr. David Starr and this writer at Leetown during 1947 showed that emulsified rotenone from both derris and cube was more quickly lethal to fish than the powdered forms; there was the additional advantage of ease of application, as the powdered forms irritate the throat during mixing operations preliminary to use for eradication of undesirable fish populations. Emulsifiable rotenone at 12.5 p.p.b., equivalent to 0.25 p.p.m. derris or cube powders with a rotenone content of 5 percent, proved adequate for the eradication of fish in experimental ponds at Leetown. Reduction of the concentration to 6.3 p.p.b. rotenone (0.125 p.p.m. powdered derris or cube), even with emulsifiable rotenone, resulted in incomplete kills of fish.

There is evidence (Siegler and Pillsbury, 1946; Wales, 1947) that rotenone may remain toxic for long periods of time in cold water, even over winter if applied late in the fall. As with other insecticides, there is much yet to be learned about the effects of rotenone upon bottom animals, plankton, and other organisms in the aquatic environment.

HERBICIDES

At Leetown, West Virginia, experiments in the control of submerged aquatic plants in aquaria and ponds containing bluegill sunfish, have demonstrated that there is no immediate danger to fish from the use of such new herbicides as 2,4-dichlorophenoxyacetic acid (2,4-D), its sodium salts and esters, 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2-methyl-4 chlorophenoxyacetic acid, o-isopropyl N-phenyl carbamate, and ammonium sulfamate at 10 p.p.m. or less. In experiments at Leetown, 2,4-D at 50 p.p.m. did not kill bluegill sunfish. Ellis and others, according to Lynch (1947), showed that 2,4-D does not become toxic to fish until it reaches a concentration of 100 p.p.m. or more. Since 5 p.p.m. of 2,4-D and 2,4,5-T are required for effective control of submerged aquatic plants, and the cost of the chemicals is still high when compared with sodium arsenite, there seems nothing to fear at present from their use.

Two 2,4-D formulas, one employing triethanolamine and the other tributylphosphate as cosolvents for 2,4-D, have been recommended (Surber, Minarik, and Ennis, 1947) for use as herbicides on emergent aquatic plants such as cattails (Typha latifolia), burreed (Sparganium americanum), softstem bulrush (Scirpus validus), willow (Salix sp.), water lily (Nuphar advena), etc. Triethanolamine

is not toxic to fish, but tributylphosphate (TBP) will kill fish at concentrations of 15 p.p.m. or more. Kerosene is also toxic; therefore, the TBP formula should be used where the spray material will fall mainly upon the vegetation to be treated.

Sodium arsenite is relatively low-priced and has been used for many years in the control of objectionable weeds in fish ponds. From 1.7 to 4.0 p.p.m., as As_2O_3, have been found effective in controlling practically all submerged flowering aquatic plants in fish ponds. Observations by Surber and Meehean (1931), and Surber (1932) have shown that sodium arsenite may be used for weed control without killing fish and many fish-food organisms. Laboratory experiments by Wiebe (1930), and the Wisconsin Committee on Water Pollution (1939), show that the common warm-water fishes are not affected by concentrations up to 10 p.p.m., as As_2O_3. Field observations (Surber, 1932) on the effects of sodium arsenite upon plankton and bottom animals failed to reveal serious and lasting effects upon them in upper Mississippi River sloughs. Treatments of sodium arsenite on four sloughs did not result directly in the destruction of abundant plankton organisms, plant or animal. Catastrophic destruction of organisms was not characteristic of the treatments. In some cases, large reductions have been noted in the numbers of organisms which were abundant before treatment, but there exist contradictory cases in which the same organisms have remained fairly numerous after treatment. For small-scale weed-control operations it has many advantages over other chemical control agents. In large-scale operations, as for control of water-hyacinths, it has been found dangerous to man and other animals (Lynch, et al., 1947).

Copper sulfate is another compound of widespread use in fish-cultural operations and in the control of objectionable algae in water-supply reservoirs. This chemical, at levels as high as 1.5 and 2.0 p.p.m., has been used extensively in the hard-water ponds at Leetown for the control of Chara and pond scum algae such as Hydrodictyon, Oedogonium, Zygnema, and Cladophora without injurious effects to fish.

There has been much contradictory evidence regarding the toxicity of copper sulfate to fish. The State of Wisconsin Committee on Water Pollution (1939) found that the fatal dose for young largemouth bass in hard water was 80 p.p.m.; for larger bass, about 160 p.p.m. On the other hand, Moore and Kellerman (1905) found 2 p.p.m. toxic to black bass in the hatchery water at Cold Springs Harbor, New York; and goldfish were sensitive to 0.5 p.p.m. of copper sulfate. Ellis (1937) found that 2 p.p.m. of copper sulfate would kill goldfish in hard water in 24 to 96 hours. Ellis found that 1 p.p.m. of copper sulfate killed the cladoceran, Daphnia magna, in 15 minutes to 2 hours, and 0.25 p.p.m. killed it in distilled water in 30 minutes to 3 hours. In a series of pond experiments at Leetown, the use of copper sulfate to destroy large masses of algae in fertilized ponds was followed, within a week to 10 days, by the production of water blooms. Production of fish in these ponds exceeded production in unfertilized control ponds but was slightly lower than in ponds which were fertilized in the same manner without copper sulfate.

Several chlorinated hydrocarbons are being used for the control of weeds in lakes and irrigation ditches. Wilber (1942) reported a great many fish killed in Cranberry Lake, Sussex County, New Jersey, by one of these compounds. Eicher (in press) has reported the successful use of ortho-dichlorobenzine and other chlorinated hydrocarbons for treatment of submerged aquatic plants. Unless these compounds are emulsified with special emulsifying agents, their specific gravity is such that they settle upon the bottom in quiet waters. Preliminary experiments with these compounds indicate that in concentrations required for the destruction of the underwater vegetation, they are highly toxic to fish. Also, their toxic effects are of long duration. Aquarium experiments (unpublished) at Leetown showed that their use resulted in slow lingering death of aquatic insects and fish.

In conclusion, the writer recommends the use of chemicals for aquatic-weed control only when no other means are practical. It has been found possible to

control submerged vascular plants, in ponds and small lakes, by the production of water blooms after the application of inorganic fertilizers. Swingle and Smith (1939, 1942) were the first to report upon this effective and uninjurious method of control. The writer (1946b) described the effects of different kinds of fertilizers upon plant growths in hatchery ponds.

There is urgent need for intensive studies on the biological after-effects of several important herbicides and insecticides. The results of these studies will probably allay fears in some cases and justify them in others.

LITERATURE CITED

Bishop, E. L.
1947. Effects of DDT mosquito larviciding on wildlife. Part III. The effects on the plankton population of routine larviciding with DDT. Pub. Health Rept. 62 (35): 1263-1268.

Cottam, Clarence, and Higgins, Elmer.
1946. DDT: Its effect on fish and wildlife. U. S. Dept. Int., Fish and Wild. Serv. Circular 11, 14 pp.

Eicher, G. J., Jr.
---- Localized weed control in management of game fish. Trans. Am. Fish. Soc. 76. (In press.)

Ellis, M. M.
1937. Detection and measurement of stream pollution. U. S. Dept. Com., Bur. Fish. Bull. 48 (Bull. 22): 365-437.

Hess, A. D., and Keener, G. G., Jr.
1947. Effect of airplane distributed DDT thermal aerosols on fish and fish food organisms. Jour. Wild. Mgt. 11 (1): 1-10.

Hoffmann, C. H.; Townes, H. K.; Sailer, R. I.; and Swift, H. H.
1946. Field studies on the effect of DDT on aquatic insects. U. S. Dept. Agr., Bur. Ent. and Plant Quar. Rept. E-702, 20 pp., 4 tables. (Multilithed.)

Hoffmann--continued

Hoffmann, C. H., and Surber, E. W.
---- Effects of wettable DDT on fish and fish food organisms in Back Creek, West Virginia. Trans. Am. Fish. Soc. 76. (In press.)

Lynch, J. J.; King, J. E.; Chamberlain, T. K.; and Smith, A. L., Jr.
1947. Effects of aquatic weed infestations on the fish and wildlife of the Gulf States. U. S. Dept. Int., Fish and Wild. Serv. Spec. Sci. Rept. 39, 71 pp. (Mimeographed.)

Moore, G. T., and Kellerman, K. F.
1905. Copper as an algicide and disinfectant in water supplies. U. S. Dept. Agr., Bur. Plant Ind. Bull. 76, 55 pp.

Nelson, A. L., and Surber, E. W.
1947. DDT investigations by the Fish and Wildlife Service in 1946. U. S. Dept. Int., Fish and Wild. Serv. Spec. Sci. Rept. 41, 8 pp. (Mimeographed.)

Odum, E. P., and Sumerford, W. T.
1946. Comparative toxicity of DDT and four analogues to goldfish, Gambusia, and Culex larvae. Science 104 (2708): 480-482.

Prevost, Gustave.
1946. V--c. DDT. Prov. of Quebec, Game and Fish. Dept., Biol. Bur. Rept. 4: 76-86. (Reprint.)

Siegler, H. R., and Pillsbury, H. W.
1946. Use of derris to reclaim ponds for game fish. Jour. Wild. Mgt. 10 (4): 308-316.

Smith, E. V., and Swingle, H. S.
1942. The use of fertilizer for controlling several submerged aquatic plants in ponds. Trans. Am. Fish. Soc. 71 (1941): 94-101.

Surber, E. W.
1932. Controlling vegetation in fish ponds with sodium arsenite. U. S. Dept. Com., Bur. Fish. Invest. Rept. 11, 39 pp.

1946a. Effects of DDT on fish. Jour. Wild. Mgt. 10 (3): 183-191.

1946b. The effects of various fertilizers on plant growths and their probable influence on the production of smallmouth black bass in hardwater ponds. Trans. Am. Fish. Soc. 73 (1943): 377-393.

Surber, E. W., and Meehean, O. L.
1931. Lethal concentrations of arsenic for certain aquatic organisms. Trans. Am. Fish. Soc. 61: 225-239.

Surber, E. W.; Minarik, C. C.; and Ennis, W. B., Jr.
1947. The control of aquatic plants with phenoxyacetic compounds. Prog. Fish-Cult. 9 (3): 143-150.

Swingle, H. S., and Smith, E. V.
1939. Fertilizers for increasing the natural food for fish in ponds. Trans. Am. Fish. Soc. 68 (1938): 126-135.

Tarzwell, C. M.
1947. Effects of DDT mosquito larviciding on wildlife. Part I. The effects on surface organisms of the routine hand application of DDT larvicides for mosquito control. Pub. Health Rept. 62 (15): 525-554.

Wales, J. H.
1947. Castle Lake trout investigation, 1946 catch and chemical removal of all fish. Calif. Fish and Game 33 (4): 267-286.

Wiebe, A. H.
1930. Notes on the exposure of young fish to varying concentrations of arsenic. Trans. Am. Fish. Soc. 60: 270-276.

Wilber, C. P.
1942. Aquatic weed control. Parks and Recreation, Rockford, Ill. (Reprint.)

Wisconsin Committee on Water Pollution.
1939. Chemical treatment of lakes and streams with special reference to the origin and control of swimmers itch, July 1939. 20 pp. Madison, Wis. (Mimeographed.)

BACK NUMBERS

Many readers who are eager to complete sets of the PROGRESSIVE FISH-CULTURIST have written to the Editors for various back numbers of the periodical. Unfortunately, only a few copies of certain issues are still available for distribution from the Washington office. It is suggested that those who have extra copies of issues might send them to the Editors of the PROGRESSIVE FISH-CULTURIST for use in filling such requests.

"I am the King of the Pribilofs."

THE LOVE LIFE OF THE FUR SEAL

Bert M. Alday

May 15

I am the King of the Pribilofs.
I am Master of all I survey.
I was born on this isle some ten years ago,
And I garnered my crown the hard way.

As a young buck, I had no ambition,
Just roamed the outskirts with the boys.
At three, I slipped thru the drive on the hill
Taking sealskins Dame Fashion enjoys.

As years rolled along, I grew big and strong.
I roared and I fought and I killed.
Two years ago I vanquished Old Joe
And captured his harem, half filled.

I'm in from the sea a bit early this year.
There's a glorious summer ahead.
Come, girls, join my party. You've nothing to fear,
But any bull on my ground will be dead.

August 15

Oh, gosh, but I'm hungry and thirsty this morn.
Thank goodness, the season's all done.
My wives are all happy, but, boy, am I worn!
Up to now, I'll admit, it's been fun.

Haven't moved from this spot the whole summer long.
I'm wrinkled. My fat is all gone.
The pups and their scrapping grate on my nerves.
I need sleep as I sit here and yawn.

Come, girls, I'm departing. Let's have a last view.
Check Molly, check Mary, check Margaret, too.
Check Amy, check Peggy, check Jessie, check Sue,
Check Polly, check Martha, check Lil, and check Pru.

Check Hortense, check Frances, check Mother McCumber,
Check Gracie, check Betty, check that little blonde number.
Please take over, Ann, check the other one hunner'.
Bye, Sweets. Be good. See you all come next summer.

A typical Iowa farm pond.

Seining the pond while censusing the fish.

(Photos by William M. Lewis.)

Clipping the left pelvic fin from a black bullhead, as a step in censusing the fish.

SOME PRECAUTIONS IN ESTIMATING FISH POPULATIONS

Kenneth D. Carlander and William M. Lewis
Department of Zoology and Entomology
Iowa State College
Ames, Iowa

In recent years, the numbers of fish in ponds or lakes have frequently been estimated (1) by poisoning the fish population (Smith, 1935; Eschmeyer, 1937, 1938; Tarzwell, 1942; Brown and Ball, 1943; Bennett, 1943; O'Donnell, 1943; and others), or (2) by analyzing mathematically the returns of marked fish (Schnabel, 1938; Ricker, 1942, 1945; Krumholz, 1944; Schumacher and Eschmeyer, 1943; and others).

While testing these two techniques for use in fish-population studies on small ponds, we found certain errors which should be pointed out. Nearly all who have had experience with these techniques recognize the errors, but individuals planning to undertake population counts or interpreting the published results do not always recognize the limitations of the methods.

A count of all the dead fish which float to the surface or which may be seen resting on the bottom after poisoning with rotenone or copper sulphate, has frequently been considered as giving a complete census of the fish in a given body of water. Even if we assume a complete kill, the number of fish seen may not represent the total fish population. In clear shallow waters, a complete count may sometimes be made; in turbid waters or in deep waters, a varying proportion of the fish may not be seen or recovered.

Some information on the percentage recovery of fish after poisoning was secured on a 0.3-acre pond in Marion County, Iowa, in October 1947. Two days prior to the poisoning, the fish here listed were caught, marked by clipping the left pelvic fin, and returned to the pond:

151	Bluegills (Lepomis macrochirus)
36	White crappies (Pomoxis annularis)
6	Largemouth black bass (Huro salmoides) fingerlings
145	Black bullheads (Ameiurus melas)
68	Golden shiners (Notemigonus chrysoleucas)

The pond was poisoned with sufficient rotenone to insure a complete kill. A few bullheads may have survived, but all other fish were killed within 3 to 4 hours. The fish were picked up as they came to the surface and wherever they could be seen dead on the bottom. Collections were made (at least once a day) on the day of poisoning, the next day, and the third and fifth days after poisoning. Of the marked fish, only the following percentages were recovered:

Bluegills	38 percent
White crappies	14 percent
Largemouth black bass	33 percent
Black bullheads	80 percent
Golden shiners	91 percent

This pond was turbid, and fish on the bottom could not be seen in water more than 4 inches deep. In clearer water the recovery undoubtedly would have been

Technical Paper No. 8 of the Iowa Cooperative Fishery Research Unit. Project No. 37 sponsored by the Industrial Science Research Institute of Iowa State College and the Iowa State Conservation Commission in cooperation with the U. S. Fish and Wildlife Service.

greater. The pond was small and had no aquatic vegetation, and the recovery was probably better than could be expected in larger weedy lakes. None of these fish could have escaped; they merely rested on the bottom in areas where they were not detected. It is significant that the rate of recovery differed greatly with the various species, so that population data based only upon recovery after poisoning would have been very misleading in species composition as well as in population density.

Whenever population figures are to be secured by poisoning a lake or pond, it would be advisable to mark some of the fish before poisoning so that the percentage recovery can be estimated.

Poisoning a fish population to secure census information is satisfactory in some situations but does not help where changes in population are the subject of investigation. After each poisoning it is necessary to start the experiment again. By marking a known number of fish in a body of water, it is possible to estimate the total fish population from the ratio of marked fish to unmarked fish in later catches. Several mathematical techniques are used in deriving these estimates, but their fundamental assumptions are very similar.

One assumption, that the marked and unmarked fish are equally mixed in all parts of the lake, is difficult to satisfy in the larger lakes. In our experiments we have limited ourselves to ponds not larger than 5 acres so that the fish can move quickly from one part of the pond to another. The estimate is made a day or two after the fish are marked; thus the fish have a chance to mix around.

On the small ponds, seining seems the most satisfactory method of collecting fish for marking and for the later recoveries. Seining seems to be relatively free from selectivity of certain species of fishes. Also, with seines it is possible to collect enough fish in a short time to complete the marking and the population estimate on 2 consecutive days. On ponds of less than 1 acre, estimates can be made on two to three ponds in a 2-day period by a crew of three men.

On one pond we found an error which might sometimes be difficult to detect. The estimate on this 0.3-acre pond was made in October. On the basis of the returns, the pond was calculated to have, besides other fishes, 300 black bullheads plus or minus a standard error of 3.9 percent (calculated by the technique described by Schumacher and Eschmeyer, 1943). The estimate looked very good, except that an earlier test had indicated a bullhead population of about 1,350. Poisoning indicated that this larger figure was about correct. The poisoning also indicated the source of the error. Just before the poisoning, a seine haul revealed comparatively few bullheads; but about 4 hours after the poison was applied, bullheads began coming to the surface all over the pond and a seine haul caught a large number of them. Apparently a large part of the population had been lying in the mud at the bottom of the pond. The population estimate had probably been within about 4 percent of the number of bullheads swimming around in the pond, but it had given no indication of the number in the mud--fish which escaped the seine during both the preliminary marking and the recovery hauls for estimation.

After this experience, we recommend that the population estimates be made only during the seasons when the fish are normally active and that part of the seining be done in the evening, when bullheads and other night feeders are active.

Other errors undoubtedly will appear from time to time in making population estimates. If an investigator remains alert and watches for such errors, however, much valuable information can be secured by either of these census techniques.

Acknowledgment

The authors wish to express their appreciation to Lowell E. Johnson, James Holland, and J. H. Durrell for permission to work on their ponds; and to Harland Chandler, J. L. Eels, Robert Cleary, William Tate, W. C. Puttmann, W. H. Hamor, Doris Cleary, Sue Lewis, and Harriet Carlander for assistance in the field work.

Literature Cited

Bennett, G. W.
1943. Management of small artificial lakes. Bull. Ill. Nat. Hist. Surv. 22 (3): 357-376.

Brown, C. J. D., and Ball, R. C.
1943. A fish population study of Third Sister Lake. Trans. Am. Fish. Soc. 72 (1942): 177-186.

Eschmeyer, R. W.
1937. Some characteristics of a population of stunted perch. Pap. Mich. Acad. Sci. Arts and Let. 22: 613-628.

1938. Further studies of perch populations. Pap. Mich. Acad. Sci. Arts and Let. 23: 611-631.

Krumholz, L. A.
1944. A check on the fin-clipping method for estimating fish populations. Pap. Mich. Acad. Sci. Arts and Let. 29: 281-291.

O'Donnell, D. J.
1943. The fish population in three small lakes in northern Wisconsin. Trans. Am. Fish. Soc. 72 (1942): 187-196.

Ricker, W. E.
1942. Creel census, population estimates and rate of exploitation of game fish in Shoe Lake, Indiana. Invest. Indiana Lakes and Streams 2: 215-253.

1942. Fish populations of two artificial lakes. Invest. Indiana Lakes and Streams 2: 255-265.

1945. Some applications of statistical methods to fishery problems. Biometrics Bull. 1 (6): 73-79.

Schnabel, Z. E.
1938. The estimation of the total fish population of a lake. Am. Math. Monthly 45 (June-July): 348-352.

Schumacher, F. X., and Eschmeyer, R. W.
1943. The estimation of fish populations in lakes or ponds. Jour. Tenn. Acad. Sci. 18 (3): 228-249.

Smith, M. W.
1935. A preliminary note on the fish population of Lake Jesse, Nova Scotia. Trans. Am. Fish. Soc. 65 (1935): 297-299.

Tarzwell, C. M.
1942. Fish populations in the backwaters of Wheeler Reservoir and suggestions for their management. Trans. Am. Fish. Soc. 71 (1941): 201-214.

Numerous means of marking have been devised during studies of growth rate, distribution and migration, and other habits of fish. The best of plans for marking--whether it be by tagging, tattooing, fin-clipping, or some other means--will fail if the fisherman neglects to report on the size of fish and the date and place of capture.

COLLECTING BASS FRY

At the U. S. Fish-Cultural Station at Tishomingo, Oklahoma, the weather during April (the bass-spawning period in that area) is usually cloudy and windy. H. C. Topel, superintendent, reports that during the 1947 season, despite particularly unfavorable weather, more than half a million bass fry were collected, largely through the use of a single gallon of cod-liver oil on three ponds comprising 5.98 acres.

The proper period for collecting bass fry is usually limited, and consequently every effort must be made to collect the fry even though the weather is not ideal. The use of oil (cod-liver or any type of fish oil) to assist in the location of bass fry has been known to many fish-culturists for years, but the information may be of assistance at a number of warm-water stations.

A small brush, part of a whisk broom, or a small bundle of weeds may be used to sprinkle a few drops of oil in the water along the windward edge of a pond. The initial application will smooth wave action in a large area that can be followed to the opposite shore of a 2-acre pond, and this effect will be maintained in a strong wind. If a prolonged "glassy" condition is desired, a light application may be made along the windward edge as frequently as the velocity of the wind requires. At some hatcheries the oil has been distributed a drop at a time from a bottle with a small hole in the cork, or with a gadget of the type used for dampening clothes.

PRELIMINARY TESTS WITH DRIP INCUBATORS

Dr. Frederic F. Fish of the Fish and Wildlife Service has recently announced the completion of preliminary tests of drip incubators at the Coleman Laboratory (California) to determine the feasibility of incubators for producing eyed eggs with a minimum volume of water. Equipment of this type, if perfected, would be extremely practical for temporary installations required for relocating salmon runs.

One incubator received 4 gallons of water manually poured through the eggs twice daily. Control groups of eggs from the same collections were incubated in the conventional manner. Loss to the eyed stage among eggs carried in the drip incubator amounted to 24.2 percent of the 165,000 eggs involved, whereas the loss among the 88,300 eggs conventionally incubated amounted to 7.6 percent. An uneven distribution of the water below the top tray in the incubator appeared to be the factor responsible for the increased losses in this equipment.

The second incubator received 24 gallons of water per day by means of an intermittent siphon which delivered about 2 gallons of water to the top spreader pan every 2 hours. Loss to the eyed stage in this incubator totalled 27.8 percent of the 126,600 eggs used, whereas losses among the control groups of 80,300 eggs amounted to only 2.1 percent. Apparently, the uneven distribution of water through the trays again was responsible for the heavy mortality in the incubator, and, in the second incubator, the greater volume of water used also permitted fungus development which further aggravated the losses.

The problem attending use of the drip incubator apparently is not one of water volume but of water distribution. The equipment is now being redesigned for tests during the coming fall.

Quarterly Report, Fishery Investigations, January-March 1948.

BROOK AND RAINBOW TROUT TREATED WITH SULFAMERAZINE AND CALOMEL OR SULFAMERAZINE AND CARBARSONE

James S. Gutsell and S. F. Snieszko
U. S. Fish and Wildlife Service
Kearneysville, West Virginia

In July 1946, some brown trout (Salmo fario) yearlings at the U. S. Fish-Cultural Station at Lamar, Pennsylvania, were treated with sulfamerazine for furunculosis. It was found during this treatment that the trout were also infected with Octomitus salmonis; therefore, a dose of calomel was given during the second week of the treatment with sulfamerazine. Two days after the calomel was administered, mortality increased considerably, remaining high until the treatment with sulfamerazine was discontinued. One of the authors examined the dying trout bacteriologically and found that they were free from the infection with Bacterium salmonicida. It was thought, therefore, that the sudden rise in mortality might be caused by a cumulative toxic effect of sulfamerazine and calomel. This incident raised the question of possible danger from the treatment of furunculosis and octomitiasis simultaneously.

In an attempt to find an answer to this question, the test described in this brief paper was begun on September 25, 36 hours after the close of experimental work (Gutsell and Snieszko, in press) to test the effect of various dosages of sulfamerazine on brook trout (Salvelinus fontinalis) and rainbow trout (Salmo gairdnerii). Prior to this interval, the trout given sulfamerazine with calomel or carbarsone in this test had received sulfamerazine with their food for 45.5 days at the rate of 10 grams per 100 pounds of fish each day. The trout which did not receive sulfamerazine in this test had not been given this drug at any time.

As shown in table 1, there were six lots of brook trout and six lots of rainbows. Assignment of treatment was by random selection. The initial weight of the brook trout per trough or lot was 1,000 grams, and the initial weight of the rainbows, 1,450 to 1,500 grams. At the beginning of the test, the number of fish per trough ranged from approximately 50 to 60 for brook trout and from 100 to 120 for rainbows.

Administration of sulfamerazine was terminated on the 9th day (after 8½ days of treatment), but observation was continued to the 14th day.

For each species, one lot which received sulfamerazine and one lot which did not receive it were given calomel, and another pair of lots (one of which received sulfamerazine) were given carbarsone. Calomel and carbarsone were included in one meal on the 3d and in one on the 9th day. The rate for each was 1 gram per pound, or 2.2 parts of drug per 1,000 parts of food. This was equivalent to 7.6 grams per 100 pounds of fish (16.7 grams per 100 kilograms). The sulfamerazine was administered daily at the rate of 10 grams per 100 pounds of fish.

As shown in table 1, there were no deaths in the lots given both calomel and sulfamerazine or in those given both carbarsone and sulfamerazine. There is,

therefore, no indication that there is any danger in administering either carbarsone or calomel with sulfamerazine in the food of trout.

TABLE 1.--Mortalities through 14 days with and without sulfamerazine and with and without calomel or carbarsone

No Sulfamerazine				Sulfamerazine							
		Calomel		Carbarsone				Calomel		Carbarsone	
Brook trout	Rainbow trout	Brook trout	Rainbow trout	Brook trout	Rainbow trout	Brook trout	Rainbow trout	Brook trout	Rainbow trout	Brook trout	Rainbow trout
2	0	4	0	4	0	2	0	0	0	0	0

Of course, the findings of this test, limited as it was, do not preclude the possibility that, under some conditions or with other species (e.g., brown trout), there may be danger in the administration of sulfamerazine and calomel or sulfamerazine and carbarsone simultaneously.

Literature Cited

Gutsell, J. S., and Snieszko, S. F. (In press) Response of brook, rainbow and brown trout to various dosages of sulfamerazine. Trans. Am. Fish. Soc. 77 (1947).

Complaints of the tired-businessman subspecies may be loud, but stomach ulcers are not restricted to Homo sapiens. Examination of fish in Marvel Lake (20 miles south of Banff in Alberta, Canada) in 1936 showed that most of the "poor" fish had ulcers in the stomach--a few had perforated stomach walls.

Excellent fish production and large quantities of weeds do not go hand in hand.

Lake Izabal, a fresh-water lake on the northern coast of Guatemala, covers approximately 275 square miles. This lake contains a fresh-water shark, sawfish, tarpon, robalo, manatee, and many other salt-water species.

EXPERIMENT ON THE CONTROL OF COLUMNARIS WITH SULFA DRUGS

Daniel W. Slater
U. S. Fish and Wildlife Service
Anderson, California

An experiment to test the effects of some of the sulfa drugs on the course of columnaris at the U. S. Fish-Cultural (Coleman) Station, Anderson, California, was planned early in the rearing season of 1947. Between May 23 and June 20, 1947, about 2,800 spring-run fingerling chinooks were placed in two troughs for this purpose. These fish had previously been used in carrying-capacity trials of troughs and had been reared entirely in troughs. As planned, these fish were held in the two troughs until significant losses from columnaris infection were observed. Losses were low until July 27, when they rose sharply and continued to increase. Weekly losses prior to and including the first 2 days of treatment are shown in table 1.

Diagnosis of the disease was made solely on the basis of macroscopic and microscopic examination of the afflicted individuals; bacteriological examinations were not made. However, previous studies of Ordal and Rucker (1944), as well as those of the present author (unpublished), have demonstrated the presence of the causative organism[1] in the visceral organs and in external lesions. Concomitant infection of the fingerlings with furunculosis has not been certainly excluded, but routine bacteriological examinations made previously at Coleman by the author make this condition extremely unlikely.

For the purpose of the present experiment, on August 14, 1947, the fingerlings were distributed as evenly as possible into 24 troughs. Fairly equal distribution of the fish was made possible by the use of the sampling device of Hewitt and Burrows (1948). At the time of distribution, the mean number of fingerlings per trough was 103.75 ± 7.08, weighing 1,100 grams and averaging 10.6 grams per fish.

Four troughs were drawn at random to receive each of the five sulfa drugs to be tested (sulfanilamide, sulfadiazine, sulfathiazole, sulfamerazine, and sulfamethazine), and four troughs were drawn to serve as untreated controls.

TABLE 1.--First losses

Week	Total loss	Percent with columnaris lesions
6/18 - 6/24	3	0
6/25 - 7/ 1	1	0
7/ 2 - 7/ 8	2	0
7/ 9 - 7/15	1	0
7/16 - 7/22	3	0
7/23 - 7/29	6	33
7/30 - 8/ 5	15	93
8/ 6 - 8/12	61	82
8/13 - 8/19	[1]180	60
8/20 - 8/26	101	76

[1]/Loss increased by handling.

[1]/The taxonomy of this organism is not clear. Ordal and Rucker (1944) have assigned the name Chondrococcus columnaris to the organism they isolated from fishes of the Columbia River drainage; Garnjobst (1945), working at Leetown, West Virginia, gave what appears to be the same organism the name Cytophaga columnaris.

Since November 1947, Mr. Slater has assigned to the U. S. Fish-Cultural Station at Cortland, New York.

The drugs were thoroughly mixed with the daily ration in amounts equivalent to 12 grams per 100 pounds of fish during the first 7 days and at half this rate during the following 7 days. Feeding of the drugs was started on August 24, and no other food was fed during the 14-day period of treatment. The whole ration was fed once daily from August 14 until the end of the experiment. The fish were held for observation for an additional 10 days after treatment.

The fish fed sulfanilamide did not clean up their feed when it was mixed with the heavy dose; in fact, by the sixth day they were leaving nearly all of it. Consequently, the dosage rate of this drug was reduced to the 6-gram level on the seventh day, that is, one day earlier than the others.

For purposes of analysis, the experimental period beginning August 14 has been divided into three 11-day periods. The first period is that prior to treatment but includes the first day of treatment, as the loss recorded for this day is actually that of the previous day. The other two periods correspond roughly to the period of treatment and that following treatment.

Losses for the three periods are given by periods and by treatment groups in table 2.

It is evident that sulfadiazine and sulfamerazine effectively controlled the disease. These two compounds are practically identical chemically. Sulfamethazine appeared to exert some control, but the effects apparently were not so lasting. Losses within the control group and the group that received sulfathiazole remained high throughout the experiment. The poor results obtained with sulfanilamide may have been due in part to the unpalatability already mentioned.

The validity of these conclusions has been tested and confirmed by means of analysis of variance.

The author is indebted to Dr. Frederic F. Fish for suggestion of the experiment and to Dr. C. M. Mottley for statistical analysis of the data.

Literature Cited

Garnjobst, L.
1945. Cytophaga columnaris (Davis) in pure culture: a myxobacterium pathogenic to fish. Jour. Bact. 49 (2): 113-128. illus.

Hewitt, G. S., and Burrows, R. E.
1948. An improved method for enumerating hatchery fish populations. Prog. Fish-Cult. 10 (1): 23-27.

Ordal, E. J., and Rucker, R. R.
1944. Pathogenic myxobacteria. Proc. Soc. Expt'l. Biol. and Med. 56: 15-18. illus.

TABLE 2.--Losses for the three periods

Drug	Numbers lost			Percent loss monthly rate			Original number of fish
	1st period	2d period	3d period	1st period	2d period	3d period	
Sulfanilamide	36	19	76	23.4	13.5	56.6	433
Sulfadiazine	36	16	4	24.5	11.9	3.1	414
Sulfathiazole	51	40	54	35.5	31.8	48.5	405
Sulfamerazine	46	28	3	30.9	21.1	2.5	419
Sulfamethazine	36	9	13	24.4	6.7	9.9	416
Control (no drug)	41	69	33	28.3	53.0	31.2	408

DISINFECTION OF RAINBOW TROUT EGGS WITH SULFO-MERTHIOLATE

EXPERIMENT WITH Sodium p-Ethyl Mercuri Thiophenylsulfonate, Lilly

S. F. Snieszko and S. B. Friddle
U. S. Fish and Wildlife Service
Kearneysville, West Virginia

Since Mackie and his associates (1930) isolated Bacterium salmonicida from the ovaries of infected trout, it has been obvious that the eggs may serve as a carrier of furunculosis from the infected brood stock to the freshly hatched fry. Fortunately, B. salmonicida was found only on the surface of the eggs (Smith, 1939), while the contents of normal trout eggs were found to be free from infection (Plehn, 1911; Williamson, 1929; and Mackie et al., 1930). The surface disinfection of fish eggs is practical only with a disinfectant which is nontoxic to the eggs in a concentration permitting a fairly rapid destruction of B. salmonicida or other pathogenic bacteria that might be carried over the surface. On the other hand, the action of the disinfectant should not be affected by the presence of proteins. Blake (1930), who tried various disinfectants, found that ácriflavine (trypaflavine), a chemotherapeutic drug used first by Ehrlich for the treatment of sleeping sickness, had the desired properties. According to Blake (1930) and Atkinson (1932), acriflavine destroys B. salmonicida in a water dilution of 1:2,000 in 20 to 30 minutes and is practically noninjurious to fish eggs. Smith (1939) made a very thorough investigation of acriflavine as a fish-egg disinfectant and found that it was actively germicidal only if properly buffered to pH 7.7. O'Donnell (1944) gave detailed instructions regarding the disinfection of eggs with acriflavine. O'Donnell and Woodbury used acriflavine for a successful control of an amoebic soft-egg disease.[1] Foster and Woodbury (1936) suggested malachite green as a general trout-egg disinfectant. The data published by Gee and Sarles (1942) indicated, however, that malachite green in bactericidal concentration is also toxic to trout eggs.

Gee and Sarles (1942) made a very thorough search for a substance which would be toxic to B. salmonicida in the presence of trout eggs, and which would be entirely safe for the eggs. They found that of the aniline dyes tried, only gentian violet could be used safely and effectively, but that it deeply stained the egg shell. Acriflavine, if used in well-buffered solution, was very useful and safe for eggs. Of all the substances tried, however, the best results were obtained with sulfo-merthiolate, a new organic mercurial. Sulfo-merthiolate was 66.7 and acriflavine only 27 times as toxic to B. salmonicida as to trout eggs.

On the basis of this information, the senior author recommended the use of sulfo-merthiolate for the disinfection of eyed trout eggs in the hatcheries of the Fish and Wildlife Service.[2] Soon

[1] O'Donnell, D. J., and Woodbury, L. A. Report of the soft egg disease at Bayfield Hatchery. Unpublished report, Wis. Cons. Dept. See W. W. Smith (1939).

[2] Sniesko, S. F. Recommendation for the disinfection of the eyed trout eggs. U. S. Fish-Cultural Station, Kearneysville, W. Va. (Mimeographed)

after distribution of the recommendation, there were inquiries as to whether so-called green eggs could be disinfected with sulfo-merthiolate. As there was no information available, an experiment was conducted to clear this point.

EXPERIMENT

Rainbow trout (Salmo gairdnerii) eggs were used for this experiment because they were the only trout eggs available at all stages of development. Trout were stripped on November 6, at 11:30 a.m., fertilized, washed, and water-hardened. Between 1:30 and 2:20 p.m., the eggs were distributed among special experimental troughs, each of which had an individual water supply and outlet. At the time of distribution there were about 1,088 eggs to 100 milliliter (321 eggs per fluid ounce). Each trough received about 3,850 eggs, which were spread in one layer on a screen hatching tray. All damaged eggs were removed before treatments were started.

The eggs were given the following treatments:

1. Sulfo-merthiolate dip. One gram of sulfo-merthiolate was dissolved in 5 liters of water (1:5,000) taken from the hatchery water supply, and the solution was poured into a metal tub, well-coated with asphalt paint. The tray with the eggs was submerged in the solution for 10 minutes, always so gently that the position of the eggs was not changed. During this time the tray was gently moved up and down once in every 1 to 2 minutes. After the treatment, the tray with eggs was returned gently to the experimental trough.

2. Sulfo-merthiolate bath. Water in the experimental trough was lowered to such a depth that the hatching tray was barely covered with water and the volume of water in the trough was calculated. Sulfo-merthiolate was dissolved in about a quart of water taken from the trough. Such an amount of sulfo-merthiolate was used as to make a concentration 1:5,000 in the measured quantity of water in the experimental trough. This stock solution of the disinfectant was poured above and below the tray containing the eggs, and the water in the trough was circulated by means of an electrically driven pump. The treatment lasted for 10 minutes, during which every precaution was taken not to disturb the eggs in the slightest manner.

3. Controls. Eggs in some of the troughs were subjected to the same handling used in the treated troughs, but no disinfectant was added to the water. In order to determine the effect of handling on the survival of the eggs, other controls were left entirely untouched during the hatching period.

4. Shocking. When all the eggs became eyed, eggs in some of the treated and control troughs were shocked on the 16th day in order to determine the effect of shocking on the disinfected and the control eggs. Shocking was done in a conventional way by pouring eggs several times from one container to another. After shocking, the eggs were replaced on the trays in the same troughs.

All the white, spotted, and fungused eggs were removed every morning, as well as within a few hours after the shocking on November 21. Eggs started to hatch on November 29, and hatching was completed on December 5. The experiment was ended on December 6, that is, on the 31st day from the egg-taking. The distribution of treatments was as presented in table 1.

The over-all results of the experiment are presented in table 2. In this table are given the numbers of white, spotted, or fungused eggs which were removed every morning, and several hours after shocking on November 21. The daily rate of loss was calculated as a percent of the eggs remaining in troughs after picking on the preceding day. In the table are given also the total numbers and percentages of the eggs removed during the experiment. The comparison of the total losses indicates that the differences in losses between troughs were very small and not significant, and that the treatment with sulfo-merthiolate diluted 1:5,000 is entirely harmless to the eggs at all the stages of development at which the eggs were treated. As is evident from table 1, some batches of eggs were treated imme-

TABLE 1.--Disinfection of rainbow trout eggs: distribution of treatments

Trough No.	Treatment	Date	Shocking Nov. 21
1a	Control		Yes
1b	Sulfo-merthiolate dip	Nov. 6, 2:30 p.m.[1/]	Yes
1c	Sulfo-merthiolate dip	Nov. 12	No
2a	Control		No
2b	Sulfo-merthiolate dip	Nov. 6, 2:30 p.m.[1/]	Yes
2c	Sulfo-merthiolate bath	Nov. 12	No
3a	Control; water dip water bath	Nov. 6 and 7 Nov. 12	Yes
3b	Sulfo-merthiolate dip	Nov. 7	Yes
3c	Sulfo-merthiolate dip	Nov. 21	No
4a	Control; water bath water dip	Nov. 7 Nov. 12	Yes
4b	Sulfo-merthiolate bath	Nov. 7	Yes
4c	Sulfo-merthiolate dip	Nov. 21	Yes

[1/] Eggs were distributed on November 6, between 1:30 and 2:20 p.m.

diately after they hardened, other batches were treated on the next or the 7th day, and some on the 16th day; also, 8 of the 12 lots were shocked on the 16th day. The development of trout eggs at the Leetown Station is fairly fast, as the temperature of the water the year round is close to 54° F.

The daily percent rate of loss shows that there was a slight but uniform increase of losses in all troughs, regardless of treatment or handling, between the 8th and 10th days. The average loss due to shocking was about 4 percent, but there was no correlation between these losses and treatments. The total number of bad eggs removed was between 26.5 and 31.7 percent per trough, but there was no evidence that treatments, handling, or shocking had any significant effect on the number of the fry hatched.

DISCUSSION

The experiments indicated that the disinfection of the eggs with sulfo-merthiolate immediately after the eggs were water-hardened, on the 1st, 2d, or 7th day of development, and when the eggs were eyed, had no significant effect on the proportion of the eggs which hatched. It must be stressed, however, that whenever eggs were disinfected or handled, they were handled very gently. As the eggs can be damaged very easily from the time when the development starts until they are eyed, disinfection should either be effected as soon as they are water-hardened or delayed until they are eyed. The data here presented indicate, however, that the eggs can be disinfected in the tender stage if the handling is so gentle that it is not injurious to the eggs.

We found that if the eggs in the tender stage were handled so gently that they remained stationary on the trays during treatment, there was no increase in the mortality of the eggs. There was also no difference in the losses recorded from batches of eggs which were removed from the troughs for treatment and dipped in a tub, and those which were treated in the troughs without movement of the trays. Disinfection in a tub is much easier and requires less water and therefore less sulfo-merthiolate to prepare the desired concentration of the disinfectant. As several trays with eggs can be treated in one batch of the disinfectant, the disinfection of the eggs in a tub is also much cheaper. Sulfo-merthiolate does not attack metal, but because even traces of zinc are toxic to fish, it is safer to dip eggs in a painted, enameled, or glass vessel.

RECOMMENDATION FOR THE DISINFECTION OF TROUT EGGS

The results just presented indicate that trout eggs in all stages of development can be disinfected safely with sulfo-merthiolate. Because the eggs are tender during the early stages of development, however, it is highly desirable that disinfection be effected either very soon after the eggs are water-hardened or after they are eyed. Eggs not in the tender stage can be disinfected in several ways: (1) The eggs can be poured into a pan or tub with the solution of the disinfectant and stirred gently with a feather or a hand during disinfection. After disinfection, eggs should be drained and placed in fresh water. (2) Eggs can be distributed on the hatching trays and then immersed with the trays in the disinfectant. After the disinfection, eggs can be placed in the hatching troughs without rinsing.

It is very important that all the damaged, clouded, and spotted eggs be discarded and destroyed with hypochlorite solution or any other strong disinfectant. B. salmonicida or other pathogenic bacteria may be within the damaged eggs, and these micro-organisms might not be reached and destroyed by sulfo-merthiolate.

According to Gee and Sarles (1942), sulfo-merthiolate in dilution 1:7,500 kills B. salmonicida in the presence of eyed trout eggs within 10 minutes. As this drug is not toxic to trout eggs even in much lower dilutions, a dilution of 1:5,000 gives better assurance of thorough disinfection. In whichever manner the eggs are disinfected, they should be exposed to the action of the disinfectant for no less than 10 minutes. During that time eggs, except in the sensitive stage, should be moved at least once every 2 minutes to expose all egg surfaces to the disinfectant.

Care should be taken not to recontaminate eggs by direct or indirect contact with any packing material, hands, or any nondisinfected equipment. If the eggs were to become recontaminated, the whole procedure of disinfection would be useless. A good way to disinfect the hands is to keep them washed with soap, and to rinse them frequently, while the eggs are being disinfected, in the same solution of sulfo-merthiolate in which eggs are being dipped. The solution of the disinfectant is entirely safe and not irritating to the skin.

As many as 50,000 eggs can be disinfected in 10 liters (2 grams) of the disinfectant solution. Several small batches of eggs can be disinfected in the same batch of sulfo-merthiolate, provided only that the solution is well aerated and not more than a few hours old. Sulfo-merthiolate powder and solution should never be exposed to direct sunlight.

Information regarding the precautions to be observed strictly while disinfecting trout eggs and regarding the necessary details of the disinfection of eggs with acriflavine, is given in a recent article by O'Donnell (1944).

LITERATURE CITED

Atkinson, N. J.
1932. A bacterial disease of trout eggs and fry and its prophylaxis with acriflavine. Trans. Am. Fish. Soc. 62: 152-155.

TABLE 2.--Number and percent per day[1/] of the removed dea

Consecutive days of the experiment	1a		1b		1c		2a		2b		Tre
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number
1			Sulfo dip						Sulfo dip		
2	14	.4	8	.2	13	.3	13	.3	7	.2	15
3	8	.2	3	.1	2	.0	5	.1	5	.2	5
4	3	.1	2	.0	1	.0	0	.0	3	.1	1
5	1	.0	1	.0	1	.0	3	.1	0	.0	0
6	5	.1	1	.0	4	.1	5	.1	3	.1	4
7	8	.2	15	.4	16	.4	16	.4	16	.4	23
					Sulfo dip						Sul
8	26	.7	22	.6	31	.8	32	.8	23	.6	25
9	63	1.7	42	1.1	63	1.8	49	1.3	58	1.5	59
10	40	1.1	29	.8	36	1.0	40	1.1	26	.7	30
11	14	.4	10	.3	15	.4	14	.4	16	.4	17
12	7	.2	8	.2	15	.4	18	.5	16	.4	14
13	23	.6	8	.2	24	.7	19	.5	22	.6	27
14	20	.5	15	.4	24	.7	13	.4	10	.3	13
15	15	.4	6	.2	14	.6	24	.7	11	.3	14
16	19	.5	20	.5	12	.6	19	.5	13	.4	12
	Shocked		Shocked						Shocked		
16 3 P.M.	125	3.5	152	4.1	7	.2	7	.2	167	4.6	5
17	20	.6	14	.4	18	.5	26	.7	20	.6	8
18	6	.2	7	.2	6	.2	7	.2	11	.3	4
19	23	.7	10	.3	22	.6	18	.5	9	.3	31
20	10	.3	14	.4	7	.2	16	.5	14	.4	10
21	11	.3	14	.4	13	.4	17	.5	13	.4	20
22	25	.7	35	1.0	43	1.2	42	1.2	33	1.0	33
23	8	.2	29	.9	32	.8	32	.9	18	.5	30
24	26	.8	33	1.0	39	1.1	20	.6	25	.8	22
25	32	1.0	50	1.5	48	1.4	65	1.9	58	1.8	32
26	37	1.1	23	.7	41	1.2	51	1.5	46	1.4	43
27	49	1.5	50	1.5	55	1.7	96	2.9	51	1.6	69
28	96	3.0	53	1.6	66	2.0	91	2.9	91	2.9	95
29	230	7.3	239	7.5	293	9.2	157	5.1	146	4.8	293
30	151	5.2	179	6.1	216	7.5	136	4.6	149	5.1	216
31	27	1.0	30	1.0	44	1.6	123	4.4	40	1.4	27
Summary:											
Original	3850		3850		3850		3850		3850		3
Total lost	1142		1122		1221		1174		1120		1
Total percent lost	29.6		29.2		31.7		30.5		29.0		3

[1/] Percent per day is the percent of the eggs removed, calculated on the basis of the number of eggs present on t

damaged eggs of rainbow trout in treated and control troughs

Number											
rcent	3a		3b		3c		4a		4b		4c	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
	Water dip											
.4	31	.8	17	.4	12	.3	6	.2	12	.3	11	.3
	Water dip		Sulfo dip				Water bath		Sulfo bath			
.1	5	.1	4	.1	7	.2	4	.1	5	.1	2	.0
.0	2	.0	5	.1	3	.1	0	.0	2	.0	3	.1
.0	1	.0	1	.0	0	.0	0	.0	0	.0	1	.0
.1	3	.0	2	.0	5	.1	7	.2	1	.0	1	.0
.6	13	.3	26	.7	17	.4	11	.3	17	.4	20	.5
th	Water bath						Water dip					
.7	21	.6	32	.8	25	.7	33	.9	26	.7	31	.8
.6	53	1.4	39	1.0	63	1.7	51	1.3	71	1.9	77	2.1
.8	32	.9	26	.7	23	.6	28	.7	36	1.0	40	1.1
.5	10	.3	15	.4	12	.3	12	.3	14	.4	20	.5
.4	15	.4	15	.4	11	.3	18	.5	27	.7	11	.3
.7	23	.6	14	.4	14	.4	17	.5	18	.5	15	.4
.4	27	.7	14	.4	10	.3	13	.4	16	.4	20	.6
.4	25	.7	13	.4	11	.3	16	.4	12	.3	10	.3
.3	22	.6	15	.4	11	.3	6	.2	14	.4	12	.3
	Shocked		Shocked		Sulfo dip		Shocked		Shocked		Sulfo dip Shocked	
.1	123	3.5	109	3.0	5	0.1	179	4.9	149	4.2	135	3.8
.2	24	.7	21	.6	8	.2	24	.7	25	.7	29	.8
.1	18	.5	11	.3	6	.2	5	.1	4	.1	4	.1
.9	22	.6	12	.3	14	.4	14	.4	16	.5	7	.2
.3	28	.8	9	.3	10	.3	9	.3	8	.2	8	.2
.6	36	1.1	5	.1	15	.4	12	.4	12	.4	10	.3
.9	45	1.4	29	.8	32	.9	31	.9	35	1.1	20	.6
.9	24	.7	19	.6	25	.7	17	.5	17	.5	16	.5
.6	14	.4	22	.6	21	.6	13	.4	15	.5	36	1.1
.9	43	1.3	51	1.5	33	.9	38	1.1	37	1.1	31	.9
.3	44	1.4	34	1.0	42	1.2	51	1.6	32	1.0	42	1.3
2.1	69	2.2	57	1.7	53	1.5	70	2.2	39	1.2	60	1.9
3.9	108	3.5	85	2.6	97	2.9	90	2.8	44	1.4	51	1.6
9.2	192	6.5	234	7.4	331	10.1	238	7.7	200	6.3	174	5.6
5.6	122	4.3	133	4.5	110	3.8	128	4.5	171	5.8	106	3.6
1.0	16	.6	10	.3	27	1.0	20	.7	22	.8	19	.7
	3850		3850		3850		3850		3850		3850	
	1211		1079		1053		1161		1097		1022	
	31.4		28.0		27.4		30.2		28.5		26.5	

revious day.

Blake, Isobel.
1930. The external disinfection of fish ova with reference to the prophylaxis of furunculosis. Salmon Fisheries 2, 10 pp. His Majesty's Stationery Office, Edinburgh.

Foster, F. J., and Woodbury, L. A.
1936. The use of malachite green as a fish fungicide and antiseptic. Prog. Fish-Cult. 18: 7-9.

Gee, L. L., and Sarles, W. B.
1942. The disinfection of trout eggs contaminated with Bacterium salmonicida. Jour. Bact. 44: 111-126.

Mackie, T. J.; Arkwright, J. A.; Pryce-Tannatt, T. E.; Mottram, J. C.; Johnston, W. D.; Menzies, W. J. M.; and Martin, W.
1930. Interim report of furunculosis committee. 65 pp. His Majesty's Stationery Office, Edinburgh.

O'Donnell, D. J.
1947. The disinfection and maintenance of trout hatcheries for the control of disease, with special reference to furunculosis. Trans. Am. Fish. Soc. 74 (1944): 26-34.

Plehn, Marie
1911. Die Furunculose der Salmoniden. Zentr. Bakt., Parasiten, I, Orig. 60: 609-624.

Smith, W. W.
1939. The disinfecting action of neutral acriflavine on Bacterium salmonicida. PhD. thesis, 61 pp. Univ. of Wis.

Williamson, I. J. F.
1929. Further observations on furunculosis of the Salmonidae. Fisheries Board, Scotland, 1, 12 pp. His Majesty's Stationery Office, Edinburgh.

SOUTHERN PONDS INSPECTED

Recently Mr. Ancil D. Holloway and Mr. Frank L. Snipes of the Fish and Wildlife Service plotted on a map of South Carolina all the ponds that belonged to members of two sportsmen's clubs, and then selected a route that would permit visits to as many as possible of these ponds. Of 30 ponds inspected, only 1 was out of balance. These ponds were sampled more or less at random, as they were not problem ponds.

Inspecting 51 ponds in Mississippi, Mr. Snipes found only 1 out of balance.

In addition, 42 ponds were inspected at the request of their owners. Seven of these ponds were out of balance.

Of the 123 ponds examined, 24 percent were fertilized. Only about 12 percent, however, were fertilized or could be fertilized adequately to maintain a "bloom."

CHANNEL CATFISH TAGGING IN WEST VIRGINIA

E. A. Seaman
West Virginia Conservation Commission
Charleston, West Virginia

Channel-catfish tagging in West Virginia has shown the usual downstream migration with an occasional short upstream migration. Adult catfish averaging 12 inches were purchased from the Riley Fish Company, Port Clinton, Ohio, and were tagged for experimental studies in two Ohio River drainage streams in the State. One thousand fish were tagged on May 12, 1947, and 800 of these were stocked in the Mud River at Milton on May 13. A No. 3 monel-metal tag was used on the jaw. On May 14, 1947, 1,000 catfish were tagged and released in Middle Island Creek at West Union. Before the fish could be stocked, they were held at the State's Palestine Hatchery for several days without feeding.

Because of the closed bass spawning period, fishing in these streams could not begin when the fish were stocked. Fishing for the channel catfish started when the bass season opened on June 28, except for the Ohio River proper and in the slack waters of this river up into smaller streams where fishing is permitted the year round. Table 1 gives pertinent information concerning the catch on the two streams. Table 2 shows the weekly catch of the catfish from each stream.

Migration was downstream except for a few fish that migrated upstream. Of the fish released in Mud River, eight fish migrated upstream. One fish went upstream 44 miles through several Ohio River locks and dams. In Middle Island Creek, two

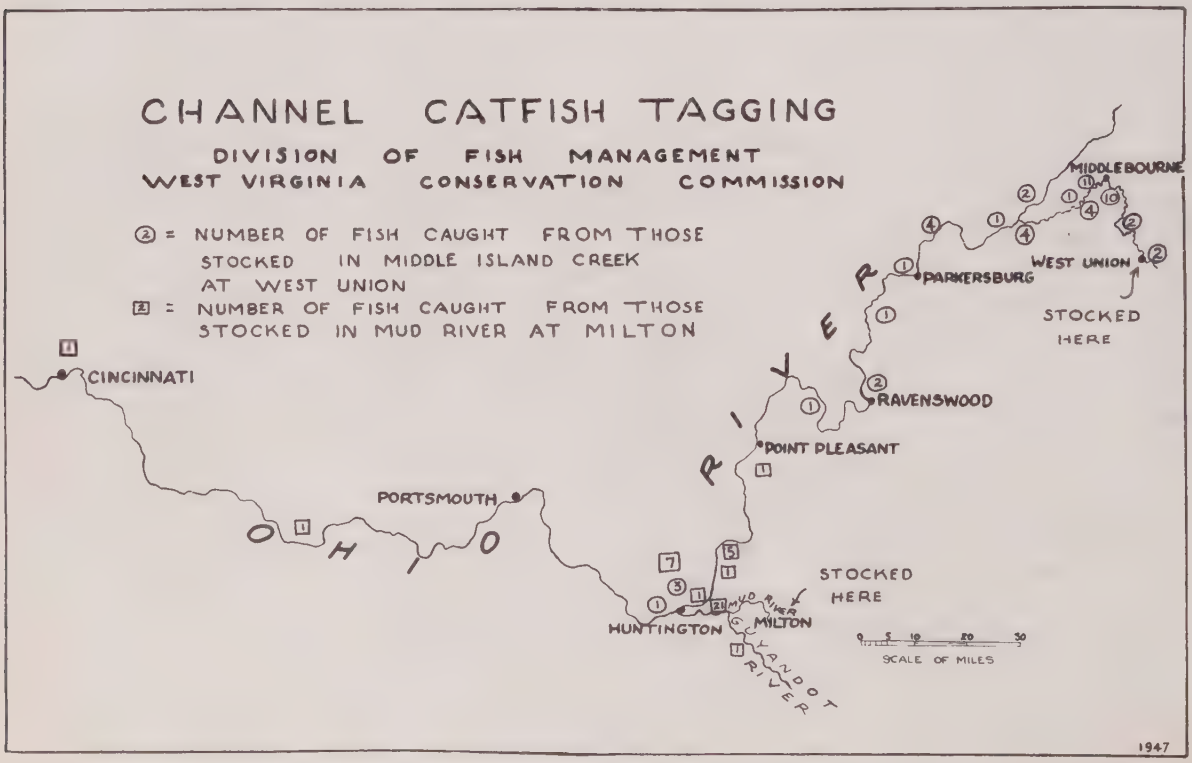


TABLE 1.--Catch on two streams

Stocking	Number of fish tagged and released	Number of fish caught	Percentage of return in tagging	Number of fishermen making catches
Mud River	800	49	6.1	31
Middle Island Creek	1,000	50 1/	5.0	36

1/ One fish recaught after being returned.

TABLE 2.--Weekly catch record

Period		Number of fish caught	
		Middle Island Creek	Mud River
1st week	(May)	0	0
2d week		0	1
3d week		1	4
4th week	(June)	2	1
5th week		0	18
6th week		1	7
7th week		1	3
8th week 1/		2	2
9th week	(July)	4	4
10th week		3	0
11th week		0	0
12th week	(August)	3	3
13th week		2	0
14th week		4	3
15th week		1	0
16th week		0	0
17th week	(September)		0
18th week			2
19th week			1
		24	49
	Plus	26 2/	—
	Total	50	49

1/ Place where fish were stocked, opened for fishing.

2/ 26 fish on record show no date when caught.

fish migrated upstream approximately 16 miles. Table 3 shows the miles of migration and the number of fish going those distances.

No contest was conducted to get returns on the tags. Posters were placed along the two streams in which the fish were stocked and in prominent places along the Ohio River.

Reports by the Geological Survey on gage height for the Ohio River at St. Mary's (at mouth of Middle Island Creek), West Virginia, show some high waters during May and June. On May 20 the height

TABLE 3.--Migration

Stocking	Miles of migration	Number of fish
Mud River[1/]	20	16
	24	1
	26	1
	27	14
	30	1
	32	2
	34	2
	35	3
	37	1
	39	1
	41	1
	73	1
	91	2
	130	1
	195	1
Middle Island Creek	0	2
	9	1
	16	1
	18	8
	28	6
	31	1
	32	1
	36	11
	54	2
	59	1
	60	1
	68	1
	83	4
	85	1
	90	1
	91	1
	96	1
	108	1
	114	1
	142	1
	148	1
	174	1
	239	1

(Photo courtesy of author)

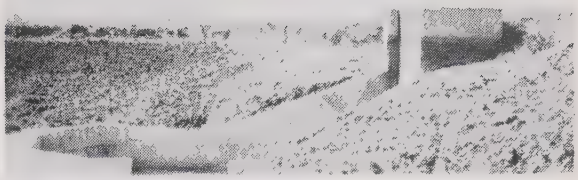
Channel catfish in raceways for distribution to streams

at this gage was 17.56 feet, and on June 9 a record of 25.22 feet was made. The lowest gage reading from May through August was 9.5 feet on August 6. These two high-water periods may have caused some migration of the channel catfish.

Gage readings at Lock No. 28 at Huntington (at mouth of Guyandotte River) show an extreme low-water reading at 14.20 feet for May 14. The highest reading was 32.78 feet on June 11.

1/All fish caught more than 20 miles below place of stocking.
Length of stream from location of stocking place to mouth, 29 miles.

1946



1948

CATTAIL CONTROL WITH SCYTHE AND 2, 4-D

C. H. Walker
U. S. Fish and Wildlife Service
Uvalde, Texas

At the U. S. Fish-Cultural Station at Uvalde, Texas, ponds were covered with such a tall, dense growth of cattails that it was difficult for a man to push his way through them. The output of the station was adversely affected by the necessity to assign personnel to cutting cattails instead of draining ponds and doing other fish-cultural work. During 1947 a program of eradication included both cutting and poisoning.

In ponds not filled with water--partly drained in order to lower the resistance of the cattails--these obnoxious plants were sprayed with a mixture of 2,4-D powder and kerosene, with tributylphosphate as a cosolvent. Mixed and sprayed in accordance with Surber's recommendations,[1] the 2,4-D was applied at the rate of approximately 20 gallons of a 5½-percent solution per acre. The ponds were blocked off with high stakes in order that the operator might know where he had applied the poison. Hand sprayers were used, as power equipment would have involved greater waste of the material. Nearly all the foliage was killed; little of it resprouted during the season.

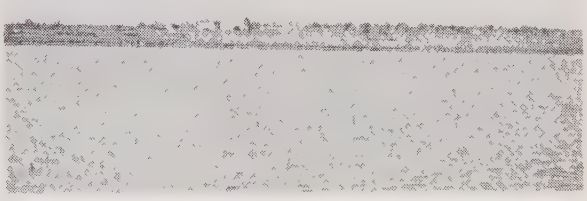
Cattails growing in ponds that were

See also:

Bauman, A. C.
1947. 2,4-D and some emergent aquatics. Prog. Fish-Cult. 9 (2): 71-77.

Surber, E. W.; Minarik, C. E.; and Ennis, W. B., Jr.
1947. Control of aquatic plants with phenoxyacetic compounds. Prog. Fish-Cult. 9 (3): 143-150.

[1] Surber, E. W. Aquatic plant control with 2,4-D. U. S. D. I., Fish and Wildlife Service Fishery Leaflet 217, 5 pp. 1947. Mimeographed.



1946

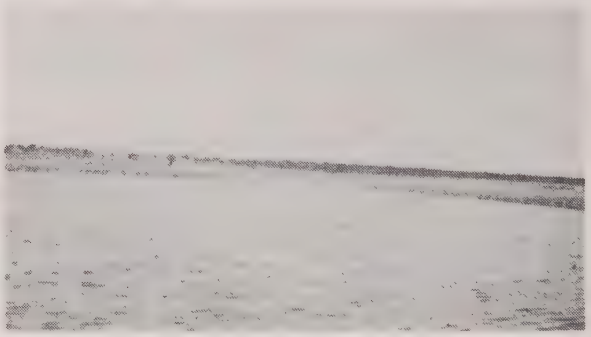
1948

filled with water were cut below the surface of the water five times with scythes. After each cutting less new growth appeared, and most of this was around the edges of the shallow parts of the ponds.

Cutting and spraying operations on these ponds may be compared as follows:

Apparently, under these conditions, the use of scythes will be more economical until the cost of 2,4-D and the mixing compound is reduced.

Cattails sprayed with 2,4-D		Cattails cut with scythes
20	acres affected	23
80	percent killed	95
$202.01	labor	$489.28
448.96	material (2,4-D, etc.)	-
650.97	total	489.28
32.50	cost per acre	21.27



COMMENTS

2830 St. Paul Street
Baltimore 18, Maryland
April 16, 1948

The Editor,
PROGRESSIVE FISH-CULTURIST,
Washington, D. C.

Dear Sir,

"Times have changed" is an old saw, and certainly applies today to some of the new theories for improving our angling. Formerly all we had to do to get bigger and better and more fish to catch, was to raise trout, bass and other freshwater game fish in our hatcheries, either to fingerling size or fry, dump them into pure water, establish a few closed seasons, sizes and daily limits, then sit back with a satisfied air for a job well done. Then go out later and reap the benefits. But said benefits, meaning more fish per hour of fishing, kept getting less and less, and the number of anglers larger and larger; and fishing got so poor somebody had to do something about it. So we called in the scientists (or did they jump in?).

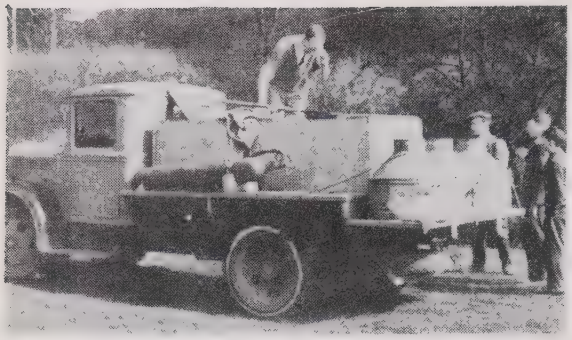
Today, according to the new theories advanced but not always proved, we can abandon our hatcheries, fish 365 days a year, and have better fishing. A few predators thrown in seem also helpful. Now I do not say these theories are all wrong, but I am a product of the old horse and buggy days, and altho born in Maryland, am "from Missouri," and want to be shown. Let's hear both sides, be sure we are right, then go ahead.

We are told that black bass do not live to ripe old ages but pass on to where good uncaught ones go when they die, before they reach the age of 5 or 6 years. This may or may not be true in some waters but certainly not so in all bass waters. In hatcheries now there are black bass that are 12 years old. I feel sure many of the 8 to 12 pound bass reported taken in waters south of the Mason & Dixon Line are over 5 years old. Also, it is said that in some waters the best fishing, for bass, is in the spring months, which to many would appear to be true, as this is the spawning period; but some tell us bass will not strike while guarding the nest; perhaps this is so in some waters, but our experience is that they can be easily taken off the nest in almost any manner.

We also are told that some waters cannot be fished out and that many waters contain too many fish, and should be fished hard throughout the year. And that predatory birds are essential to an increase of fish in such waters. But what species, and sizes of fish, and what waters? These things may all be true and undoubtedly are in some ponds and lakes. It undoubtedly applies to the myriads of too small bluegills, crappie and yellow perch, underfed, but not to black bass of a size large enough for sport and food. In some waters so infested with ancient and undersized fish, with a food supply insufficient to keep body and soul together, no closed seasons and no daily and size limits are beneficial; but only to the point where this excess of undesirables has been placed under control.

I am wondering if the cause of a lot of this trouble is not that little devil the sunfish and his relatives. For years we have been stocking bluegills along with bass. I never could catch bass with sunfish for bait; they won't touch them unless there is no other food available. Maybe we have been overdoing this bluegill restocking business. I know that where I get my best bass fishing, bluegills are scarce or nonexistent.

We do know that hatcheries are essential for good fishing management. All theories in the world cannot disprove this; I have stocked totally barren waters with bass and trout fry, and obtained results. Of course, millions of fish reared in hatcheries are unwisely distributed and dumped into unsuitable waters, and perish. But some do, under proper conditions, survive and furnish sport.



Let us not abandon our hatcheries too quickly, for they still are essential in good fish management programs.

So what does it all add up to? To me, it means we should go slowly in abandoning old ideas; do not dispose of closed seasons for any waters until you know that is the right answer; it may be exactly the thing needed to build up the crop. Too many states are opening too many of their waters the year round without sufficient knowledge of conditions prevailing in those waters. Maybe they are right, but doubtless many are wrong. The PROGRESSIVE FISH-CULTURIST, a very valuable publication, has a duty to perform to those on both sides of these momentous questions. Let us see more of the arguments of those who feel that some of the new ideas have not been proved and may not work; and that there should be more experimentation, or even proof positive, before deciding a hatchery, or a closed season, or size limits are not essential in the specific waters involved, before revolutionary steps are taken. What is sauce for the goose is not always sauce for the gander; what is good for one lake or stream may be poison in another. We have closed seasons in Maryland and we have better bass fishing than many states to the south that have no closed seasons. And we want to keep it that way. Find us the right answers--no guesses--after considering all the facts

Very truly yours,

/s/ Talbott Denmead

Talbott Denmead, Pres.
Md. Sportsmen's Luncheon Club.

SURREY TROUT FARM & UNITED FISHERIES, LTD.

The Surrey Trout Farm,
Haslemere.

The Editor,
PROGRESSIVE FISH-CULTURIST,
Fish & Wildlife Service,
Washington, D. C.

Dear Sir, March 30th 1948.

Herewith my request to be continued for mailing of your most excellent publication. It is full of interest to me and I wish we had the time and outlay to spare to try out many of the ingenious contrivances. I am afraid that purely commercial concerns have to keep within closer limits! Oh for a Glass Fish Tank like Colorado's! We would hurriedly be moved on by the Police Forces.

The description of the 2 and 6 compartment fish travelling tank-lorry in your earlier issue was of particular interest. We have been using that method of delivery since 1930. First with a heavy wooden tank, 6 x 3 x 3 feet, one compartment; but now superseded by smaller tanks of 130, 200 and 500 gallons, of rivetted and galvanized steel. The enclosed photo of 2 x 200 gallon tanks making a 2-ton load may interest you, from 1938.

So far we have always used oxygen for aeration, without any special cooling or air-pumping apparatus.

I would be most grateful if you can possibly favour me with any details of the "Venturi" valve or apparatus--I cannot quite place what it consists of?

We get good results with porous tubes of amorphous carbon which split the oxygen well into small bubbles; but tubes vary in quality and length of life through gumming up.

With every good wish for the future of your work,

Yours truly,

/s/ D. F. Leney

RELATING TO PUBLICATIONS

EXCERPT

FERTILIZATION OF OUR WATERS

The magnificent results of fertilization carried on in artificial pools in the United States have convinced many sportsmen in this Province that the process could produce analogous results in our speckled trout lakes.

The attempts carried out in this Province have given us highly (9, 15) variable results, and have showed us the necessity for establishing a research program covering several years before we can establish a policy concerning fertilization. The factors to be considered are very numerous and complex, as may be seen by the following report.

For growth, the trout requires proteins, fats, sugars, mineral salts, etc., products which he obtains by devouring insects, worms, crustaceans, and microscopic organisms classified under the name of Plankton animals. The latter, in turn, take their nourishment from bacteria and microscopic plant organisms whose development is conditioned by the absorption of different elements: carbon, oxygen, hydrogen, phosphorous, mineral salts, etc. These are precisely the elements present in chemical fertilizers. One must not expect, however, after introducing fertilizer into a lake, to see trout schooling toward shore to feed directly on it, for these fertilizers, before they can serve as food for fish, must pass through a whole series of changes in lower organisms, tiny plants or animals. Nor must we hope to see as a result an obvious growth in herbaceous vegetation, although this latter phenomenon may be produced in certain cases. Rather, what we must remember is that the fertilizer serves only to contribute to the development of microscopic plant organisms which in turn become food for animal organisms.

The productivity of these microscopic plants depends on several factors, among them the intensity of sunlight and the temperature of the water.

Actually, without the aid of sunlight, these organisms could not extract carbonic gas from the water and absorb from it the carbon which is absolutely indispensable to their development. In our province, the intensity of this light is rather limited as the lakes, covered with ice for several months, are exposed to the rays of the sun for a relatively short time. Moreover, the cold temperature of our waters is not such as to favor the development of these organisms.

These two factors, light intensity and temperature, suffice to show us that the productivity of our waters is limited and that the growth of fish in Quebec will be slower than that in the southern United States.

Even under equivalent conditions of temperature and light intensity, results may be highly variable according to the nature of the habitat. Results will be poor if we fertilize lakes of high acidity, with rocky or sandy bottoms, and steep banks. They will be good if we are dealing with shallow alkaline lakes, with silt or calcareous bottoms.

If, to all these factors, we add that of natural fluctuations in the number

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By permission. Section V-b (pages 71, 73, 75, and 77) of the Fourth Report (1946) of the Biological Bureau, Game and Fisheries Department, Province of Quebec.

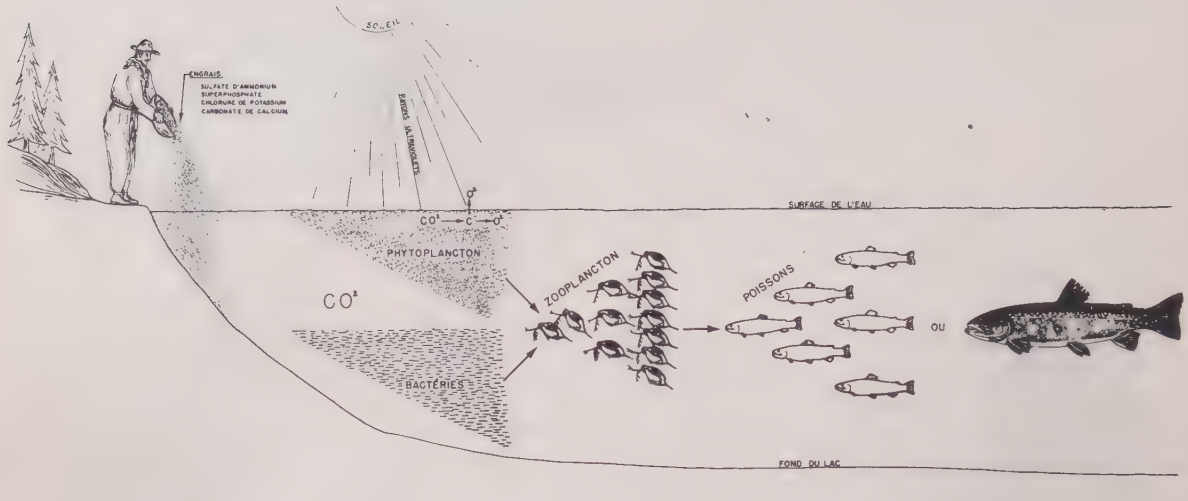

Fig. 11--Effect of chemical fertilizers.

of fish or nutritive organisms, fluctuations caused by disease, death, meteorological conditions, etc. one may see that it is difficult to determine the specific effects of fertilizers. These effects may give rise to numerous hypotheses, among them:

1°--An increase in the size of the speckled trout:

This increase may be due to a growth in nutritive organisms by the mechanism described above.

It may also be attributed to a decrease in the number of trout, caused by the following phenomenon: the fertilizers provoke the intense development of microscopic plant organisms which, after their death, fall to the bottom of the lake where they decompose, forming a considerable amount of organic material which absorbs the oxygen dissolved in the water and makes the area uninhabitable for speckled trout. These undesirable conditions cause the death of a certain number of trout, thereby leaving more food for these which survive.

In the first case, the chemical fertilizer has an authentic effect on the growth of the trout, while in the second case it seems to show a nutritive value which it does not actually possess.

2°--Increase in the number of trout without any growth in their size:

Fertilizers may favor the development of a larger fish population, without causing any increase in the size of the individuals. (Chart 11)

We are thus led to believe--granted the difficulty in evaluating the fish population--that the fertilizer is ineffective.

3°--Decreased catches of fish:

The fish, as a result of fertilization, may grow and multiply in large numbers, but it does not necessarily follow that the ease of catching the speckled trout will be likewise increased. On the contrary, in trout lakes containing minnows, fertilizers may very easily favor the development of the latter at the expense of the trout. Moreover, in certain lakes, chemical fertilizers may cause a very intense development of phytoplankton which form a thick surface layer, so dark colored as to prevent the trout from seeing the artificial fly when it is offered to him.

The catch will be diminished in both these cases.

4°--Complete ruin of the lake:

Fertilizers may cause a disproportion-

ate development of organic substances and, in shallow lakes, a decrease in oxygen sufficient to cause the death of all the trout.

Many other hypotheses could be drawn up. Any doubts we may have on the effects of fertilization are born out by Dr. J. R. Dymond, who writes: "It must be remembered in this connection that there is a great difference between the warm-water species --largely bass of various species which thrive in southern waters--and the cold water species, especially trout, of our northern waters.

"Research is necessary before we can learn to fertilize our northern cold trout waters so as to increase their productive capacities. Since these are so poor in nutrients to begin with, there may well be a limit to the size of waters which it may be economically feasible to fertilize." (2)

We must not lose sight of the fact that, to be advantageous, chemical fertilizers must favor the growth of fish without decreasing the pleasures of fishing.

LITERATURE CITED

2--Dymond, J. R. 1946. "Fresh and Salt Water Fish". Conservation Illustrated, 1: 93-97.

9--1944--Second Report of the Biological Bureau, pp. 30-53. Prov. of Quebec, Game and Fisheries Department.
1945--Third Report of the Biological Bureau, pp. 44-67. Prov. of Quebec, Game and Fisheries Department.

15--Taylor, B. W. 1944. "Fertilizing Lakes". An illustrated lecture delivered by Taylor, B. W. to the Angler's Association of the Province of Quebec on March 6, 1944. Biol. Bureau Library, MS 1519.

ABSTRACT

AMERICAN FISHERIES SOCIETY

THROUGH the courtesy of Dr. Russell P. Hunter (Secretary) and Dr. Ralph Hile (Chairman of the Editorial Board), we have been permitted to prepare the following abstract of a paper presented at the 77th Annual Meeting of the American Fisheries Society:

THE RATE OF GROWTH AND SEX RATIO FOR SEVEN MICHIGAN FISHES

William C. Beckman
Michigan Department of Conservation
Institute for Fisheries Research
Ann Arbor, Michigan

The average size for the various age groups is presented for seven Michigan fishes: the bluegill (Lepomis m. macrochirus), yellow perch (Perca flavescens), pumpkinseed (Lepomis gibbosus), rock bass (Ambloplites r. rupestris), largemouth black bass (Micropterus salmoides), smallmouth black bass (Micropterus d. dolomieu), and the black crappie (Pomoxis nigro-maculatus). Ages were determined for 25,723 specimens. Only two species showed consistent sex differences in growth rate. The female yellow perch grew more rapidly than the males, and the male rock bass were consistently larger than the females of corresponding age.

Sex ratio for each of the species is presented. The percentage of males varied from 39 percent in the yellow perch to 52 percent for the pumpkinseed and black

crappie.

Weights for each of the age groups were calculated from the length-weight equations.

FROM OTHER SOURCES

TIME OF ACTIVITY OF FRESHWATER FISH SPERMATOZOA IN RELATION TO TEMPERATURE. Arne Lindroth. Zool. Bidrag Uppsala 25: 165-168. (1947).--The various swimming times of the pike, lote, perch, bream, rudd, and salmon were determined at three or four different temperatures between 4° and 23° C. The values obtained indicate that the swimming time of the fish spermatozoa is an exponential function of the temperature. The roe and the milt probably are released almost simultaneously, and the closing of the micropyle starts at approximately the same time as the swimming of the sperms. The sperms of cold-water spawners have shorter swimming times than the warmer-water spawners.

NOTES ON THE 1945-1946 BASS BREEDING SEASON AT JONKERSHOEK INLAND FISH HATCHERY. S. S. DuPlessis. Union South Africa Inland Fish. Dept. Rpt. 3: 12-14 (1946).--Largemouth bass nested October 8 with water temperature at 63° F. Rearing ponds were fertilized with compost and kraal manure. Fingerlings grew better in dirt pools than in concrete rearing tanks. Smallmouth bass commenced breeding October 8. Fry were fed successfully on liver and fish mixed with salmon egg meal.

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Fish farming: management of water for fish production. A. D. Butcher and G. T. Thompson. Fisheries Pamphlet 3, 36 pp., illus. June 1947. (Fisheries and Game Department, Victoria, Australia.)

The preparation and use of Harvey's reduced strychnine reagent in oceanographical chemistry. D. Rochford. Bull. 220 (Division of Fisheries--Report 13), 32 pp., illus. 1947. (Council for Scientific and Industrial Research, Melbourne, Australia.)

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